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Evaluating nocturnal oxygen desaturation in COPD — revised

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Summary
Background: Although in patients with COPD, the approach to daytime hypoxemia using long-term oxygen therapy (LTOT) is established, the best approach to transient nocturnal desaturation varies among clinicians. An understanding of the prevalence of nocturnal desaturation in COPD, in the absence of other respiratory co-morbidities, is an important step towards its standardized management.
Methods: We conducted a 5 site cross-sectional study of stable patients with COPD and mild-to-moderate daytime hypoxemia (PaO_2 56–69 mmHg). Nocturnal saturation was monitored using home oximetry on 2 occasions over a 2-week period. Patients were classified in 3 categories: (A) no significant nocturnal desaturation; (B) significant nocturnal desaturation without evidence of sleep apnea; (C) significant nocturnal desaturation with evidence of sleep apnea.
Results: In 128 patients (mean FEV_1: 37% predicted), we noted an excellent test-retest reliability between the 2 oximetries. Forty-nine patients (38%) were classified as nocturnal desaturators without evidence of sleep apnea, and 20 patients (16%) were classified as desaturators with evidence of sleep apnea. Nocturnal desaturation without sleep apnea could not be predicted by any patient characteristic or physiological measure.
Conclusions: A significant proportion (38%) of patients with moderate-to-severe COPD who do not qualify for home oxygen therapy based on their daytime PaO_2 have nocturnal oxygen desaturation without evidence of sleep apnea. Home oximetry is an effective practical method for screening this population.

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Introduction

Several studies have demonstrated oxygen desaturation during sleep in patients with COPD.[1–8] Two landmark multicentre studies included patients with marked daytime hypoxemia qualifying for long-term oxygen therapy (LTOT). In subsequent studies of patients not qualifying for LTOT, the populations were heterogeneous and the definition of desaturation varied. Moreover, subjects were not evaluated under usual conditions of sleep, but underwent formal respiratory polysomnograms.[3,6–8]

There is limited information regarding the extent to which patients with moderate and severe COPD not qualifying for LTOT experience transient nocturnal desaturation. One of the reasons for this situation is that the current definition of "significant nocturnal oxygen desaturation" is arbitrary and still controversial. Nevertheless many physicians will prescribe nocturnal supplemental oxygen for such patients although the beneficial effects of this therapy have yet to be confirmed. Workshops of the National Heart, Lung, and Blood Institute (NHLBI) on the needs and opportunities for clinical research in COPD identified nocturnal oxygen therapy as a research priority, in order to inform clinical decision making with regard to home oxygen therapy.[9,10] It is therefore important to obtain an accurate estimate of the prevalence of nocturnal desaturation in this population prior to initiating clinical trials of nocturnal oxygen therapy. Therefore, the primary objective of this study was to determine the proportion of nocturnal oxygen desaturators in a population of patients with COPD and mild to moderate daytime hypoxemia. Our secondary objectives were (1) to determine, in a pilot study, the accuracy of home nocturnal oximetry to distinguish between sleep apnea and nocturnal oxygen desaturation alone, and (2) to examine the reproducibility (test-retest reliability) of home oximetry and the concordance of its interpretation between respiratory clinicians and a respiratory sleep specialist.

Methods

Patients

This study took place in 5 Canadian outpatient respiratory clinics (Hôpital Laval, Québec; West Park Healthcare Centre, Toronto; Montreal Chest Institute; Hôtel-Dieu de Lévis and Ottawa Hospital), all of which offer a wide range of health care services to patients with moderate-to-severe COPD.

We included patients with (1) a diagnosis of COPD supported by a history of past or current smoking and obstructive lung disease with an $FEV_1 < 60\%$ predicted and an $FEV_1/FVC < 70\%$; and (2) mild-to-moderate daytime hypoxemia with a daytime PaO_2 measured in a sitting position in the range of 56—69 mmHg. Patients were excluded if (1) they had experienced an acute exacerbation within 6 weeks, (2) were receiving LTOT, (3) had a prior diagnosis of sleep apnea, (4) had morbid obesity (body mass index > 40 kg/m^2), or (5) had any cardio-respiratory comorbidity (such as left heart failure) that might influence the validity of the results.

Home nocturnal oximetry and definition of "nocturnal oxygen desaturation"

After obtaining informed consent, each patient underwent two home oximetries over a 2 week period, using a digital recording system (Palmsat 2500, Nonin Medical Inc., Plymouth, MN, USA) for nocturnal saturation (SaO_2) monitoring and accepting a minimum recording time of 4 h. Nocturnal desaturation was defined as $\geq 30\%$ of the recording time (time in bed) with a transcutaneous $SaO_2 < 90\%$.[8,11]We also noted the mean number of desaturations $\geq 3\%$ per hour (desaturation index), the baseline saturation, and the average saturation over the entire tracing.

Each patient was classified into categories based on the recording time with an $SaO_2 < 90\%$ along with a visual inspection of the printed report. They were classified as having (1) no significant nocturnal desaturation ($<30\%$ time with $SaO_2 < 90\%$ for both oximetries); (2) significant nocturnal desaturation ($>30\%$ time with $SaO_2 < 90\%$ on either of the oximetries) without evidence of associated sleep apnea (no periodic variation in saturation) (Fig. 1A); and (3) significant nocturnal desaturation ($>30\%$ time with $SaO_2 < 90\%$ on either of the oximetries) with evidence of associated sleep apnea (cyclical changes in saturation as well as desaturation on either of the oximetries) (Fig. 1B).[12] All reports were reviewed by a respiratory sleep specialist (FS) with extensive experience in oximetry assessment, who was unaware of the diagnosis submitted by the other investigators.

Pilot study: validation of home oximetry in nocturnal desaturators

In a subgroup of nocturnal desaturators (i.e., patients with $>30\%$ time with $SaO_2< 90\%$ on either of the oximetries, regardless of the suggestion of sleep apnea on oximetry tracing), we conducted a blind comparison of home nocturnal oximetry and laboratory polysomnography obtained within 2 weeks of the second home nocturnal oximetry. This study was conducted in a single centre (Quebec). The polysomnographic recordings included continuous acquisition of electroencephalogram, electrooculogram, submental electromyogram, naso-oral airflow with thermistors, nasal pressure with nasal cannula), chest and abdominal movements with impedance plethysmography (RespitraceÆ, Ambulatory Monitoring Inc, Ardsley, NY), electrocardiogram, and breath sounds by means of two microphones connected to a calibrated sound analyzer. Sleep position was continuously assessed by the attending technician. All variables were digitally recorded (Sandman EliteTM system, Mallinckrotd, Kenilworth, NJ). Sleep apnea was considered to be significant when the apnea/hypopnea index ≥ 15/h.

Other measures

Within 1 month of the first nocturnal oximetry, we extracted baseline clinical information from the medical record (anthropometric measures, current medications, pulmonary function tests) and obtained arterial blood gases while patients were seated and breathing room air. In all sites,