Primary Care Respiratory Journal (2004) **13**, 155—158

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PRIMARY CARE RESPIRATORY JOURNAL

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ORIGINAL RESEARCH

Can pulse oximetry select patients for screening spirometry?

Eduardo Garcia-Pachon*

Department of Internal Medicine, Hospital Vega Baja, Orihuela-Alicante, Spain

KEYWORDS
Chronic obstructive pulmonary disease;
Oximetry;
Screening;
Spirometry

Summary *Aim:* To investigate whether the measurement of arterial oxygen saturation (SpO_2) with pulse oximetry can identify those patients for whom spirometric screening for COPD would be useful, and those patients for whom spirometric assessment would not be useful.

Methods: Two hundred and ten patients, aged over 40, without significant dyspnoea, referred by their primary care physicians to the outpatient pulmonary clinic. The value of SpO_2 was recorded with a finger clip pulse oximeter sensor. Diagnostic values were obtained in order to diagnose COPD (defined as an FEV_1/FVC ratio <0.70), and in order to detect patients with an FEV_1 $<80\%$ of predicted value.

Results: With SpO_2 $<98\%$, sensitivity for detecting COPD was 79% and specificity 37%. Similar values were obtained for detecting patients with FEV_1 $<80\%$. When only patients with FEV_1 $<50\%$ were considered, using a value of $<98\%$ for SpO2, sensitivity was 77%.

Conclusion: Pulse oximetry is not a useful test for selecting patients for screening spirometry in order to diagnose COPD.

Introduction

Many patients with COPD remain undiagnosed, and experts agree that it would be desirable to have some test or intervention that would allow early identification of COPD. A consensus statement from the National Lung Health Education Program in the USA recommended the widespread use of spirometry by primary care physicians in order to identify those patients at high risk of developing COPD [1]. However, controversy remains as to whether spirometry is the ideal test [2] since spirometry is time-consuming, relatively expensive, and needs trained operators. Moreover, Hankinson [3] stated that the indiscriminate use of office spirometry should be reconsidered because of the potential impact of poor quality spirometric recordings. Nevertheless, it is clearly necessary to improve the early recognition of COPD in order to initiate preventable and therapeutic measures [2,4]. In addition, an important component of the economic costs of COPD is considered to be due to non-diagnosis or late diagnosis [5].

The measurement of arterial oxygen saturation may be an aid in the identification of these patients since arterial hypoxaemia in COPD occurs frequently and relatively early in the natural history of the disease. The PaO_2 in patients with COPD correlates with the forced expiratory volume in 1 s [6], and, in patients with asthma of varying severity hypoxaemia was related to the degree of obstruction [7]. The portability and 'easy to use' nature of pulse oximeters make them potentially attractive

*Present address: Section of Pneumology, Hospital General Universitario, E-03203 Elche, Alicante, Spain.
Tel.: +34-96-667-9000; fax: +34-96-667-9108.
E-mail address: egpachon@hotmail.com (E. Garcia-Pachon).

1471-4418/$30.00
doi:10.1016/j.pcrj.2003.11.006

for primary care workers [8]. The objective of this study was to investigate whether the measurement of arterial oxygen saturation with a simple and inexpensive method (pulse oximetry) can identify those patients in whom spirometric screening for COPD would be useful, and those patients in whom it would be less useful.

Materials and methods

Two hundred and ten consecutive patients aged over 40 who attended the Outpatient Pulmonary Clinic were included in the study. All patients were referred to the clinic from their primary care physicians for evaluation of respiratory problems including sleep-disordered breathing. Patients with any of the following criteria were excluded: referral because of dyspnoea; patients presenting with basal dyspnoea score higher than 1 in the Medical Research Council Scale [9]; patients unable to perform spirometry; and patients with haemoptysis, or with suspicion of tuberculosis.

During the visit, while sitting, the patients had an adult articulated finger clip pulse oximeter sensor attached (model 8000 AA, Nonin Medical, Inc.; Plymouth, MN, USA) for at least 3 min. The value of oxygen saturation was recorded when stabilized, and when it oscillated between two values the lower one was considered. Immediately after the visit the patients underwent spirometry performed by a trained technician (blinded to any other data) in a separate room, according to standard criteria [10] with a portable spirometer (PonyGraphic, Cosmed SRL, Rome, Italy). Reference values for the Mediterranean population were used [11]. COPD was defined as a ratio of forced expiratory volume in 1 s (FEV_1) to forced vital capacity (FVC) of less than 0.7, and patients were classified according to a recent international consensus [12].

Pearson's correlation test was calculated between oxygen saturation and the spirometric variables. Sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio were calculated at several values of oxygen saturation for the following:

(1) Diagnosing COPD ($FEV_1/FVC < 70\%$) in all the patients; and independently in the group of patients with a history of smoking more than 20 pack-years.
(2) For detecting significant COPD (FEV_1 <50% of predicted, stage IIB and III in the GOLD classification [12]).
(3) For detecting patients with FEV_1 <80% of predicted value.

Results

One hundred and fifty-four patients were men (73%), and 56 were women (27%), mean age 62 years (S.D. 11years). One hundred and ten had a history of smoking of more than 20 pack-years. Fifty-eight patients had COPD (prevalence, 28%); 26 of them had an FEV_1 <50% of predicted. Of the 210 patients, 103 (49%) had an FEV_1 value <80% of predicted value. There was a significant ($P < 0.001$ in all cases) correlation between the oxygen saturation and the spirometric variables (FEV_1 percentage of predicted, $r = 0.41$; FVC percentage of predicted, $r = 0.40$; and FEV_1/FVC, $r = 0.34$).

The diagnostic value of oxygen saturation at several values (from 95 to 99%) for diagnosing COPD is detailed in Table 1. Using a cut-off value of <98% oxygen saturation, sensitivity for COPD diagnosis was 79% and specificity 37%. In order to ensure 100% detection of all cases of COPD the SpO_2 cut-off value should be <99%, but then the specificity is only 7%. The calculations in the 110 smoking patients showed similar findings; with a cut-off value of <98% oxygen saturation, sensitivity of COPD diagnosis was 76% and specificity 31%. All of the 45 smokers with COPD had an oxygen saturation level <99% but so did 64 of the 65 smokers without COPD (sensitivity 100%, specificity 2%). When more severe COPD was considered (FEV_1 <50%), for an oxygen saturation <98% sensitivity of COPD diagnosis was 77%; consequently 6 of the 26 patients with severe COPD were

Table 1 Diagnostic value of oxygen saturation for detecting obstructive airway disease ($FEV_1/FVC < 0.70$).

Arterial oxygen saturation (%)	Sensitivity (%)	Specificity (%)	Positive likelihood ratio	Negative likelihood ratio
<95	31	89	2.77	0.77
<96	50	76	2.05	0.66
<97	64	53	1.36	0.67
<98	79	37	1.25	0.56
<99	100	7	1.07	0.00

Table 2 Diagnostic value of oxygen saturation for detecting FEV_1 <80% of predicted.

Arterial oxygen saturation (%)	Sensitivity (%)	Specificity (%)	Positive likelihood Ratio	Negative likelihood ratio
<95	28	93	4.20	0.76
<96	45	80	2.27	0.68
<97	53	60	1.32	0.77
<98	74	38	1.19	0.68
<99	98	8	1.07	0.23

not detected with this method. The diagnostic values of oxygen saturation for detecting FEV_1 <80% are shown in Table 2. Results were similar to those for diagnosing COPD in terms of the FEV_1FVC ratio.

Discussion

The prevalence of COPD in several studies [13-18] has been found to be between 4.5 and 9.9%. In a large study [13] the prevalence of COPD in people aged 40-70 years, non-selected for respiratory symptoms or tobacco exposition, was 9.1%. Importantly, 78% of COPD patients had not been previously diagnosed, including 50% of those with more severe disease [13]. For early identification of COPD patients the widespread use of office spirometry by primary care physicians has been recommended [1]. Nevertheless, this strategy is controversial because spirometry needs experienced operators and there can be difficulty in obtaining good spirometric recordings in general practice even after training workshops [19].

The objective of this study was to evaluate whether the measurement of arterial oxygen saturation by pulse oximetry (a simple, rapid, and inexpensive method that does not require experienced operators) can select patients who are suitable for screening spirometry with a view to improving diagnosis rates of COPD. These results show that, in order to detect all patients with COPD it is necessary to have a cut-off value for SpO_2 at <99%, a value so high that we can avoid performing spirometry in only 6.5% of those patients who do not have COPD. With a lower cut-off value (oxygen saturation <98%) we can detect 79% of COPD patients, with a specificity of 37%. When smokers alone are considered, results in terms of sensitivity and specificity are no better.

A possible use of pulse oximetry might be to detect patients with more severe COPD, who are frequently undiagnosed. However, from these results, pulse oximetry does not achieve this objective. 23% of the patients with significant COPD (FEV_1 < 50% predicted) remain undetected when using a cut-off value for SpO_2 of 98%. When pulse oximetry was used for detecting those patients with FEV_1 <80% predicted (both of obstructive or non-obstructive origin) results were similarly poor.

These results should be considered in the context of other means for selecting patients for screening spirometry. Several physical signs have been evaluated for the detection of COPD, and some of them alone or in association with medical history data may be very useful for this purpose [20-23]. In fact, by using an overall clinical impression for diagnosing COPD, reported values [21-24] of sensitivity (50-64%) and specificity (64-93%), and likelihood ratios (positive 1.4-7.3, negative 0.4-0.8) are of interest. Although these studies were performed with different inclusion criteria, their results are no worse than ours obtained by using pulse oximetry.

In conclusion, although arterial oxygen saturation levels correlate with FEV_1, pulse oximetry is not a useful test for the selection of patients for screening spirometry.

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