Limitations of a spirometry interpretation algorithm

Anthony D. D’Urzo MD MSc CCFP FCFP
Itamar Tamari MD CCFP FCFP
Jacques Bouchard MD
Reuven Jhirad MD CCFP FCFP
Pieter Jugovic MD MSc CCFP


Clinical question
Does the commonly promoted spirometry interpretation algorithm¹ allow clinicians to diagnose chronic obstructive pulmonary disease (COPD) and is the definition of reversibility of airflow obstruction used appropriately?

Reassessing a widely recognized algorithm
Members of the Primary Care Respiratory Alliance of Canada have undertaken a critical appraisal of a spirometry interpretation algorithm that is a component of an interactive CD-ROM titled Spirometry in Primary Care.¹ This CD-ROM is produced by the Ontario Lung Association and endorsed by the Ontario Thoracic Society, the Ontario Respiratory Care Society, and the Family Physicians Airways Group of Canada. The interactive CD-ROM includes both didactic and case-based learning strategies. Physicians using the CD-ROM are eligible for Mainpro-C credits from the College of Family Physicians of Canada. It should be noted that this algorithm can be used for both adults and children, although some school-aged children might not meet international criteria for spirometry.²

Overview and analysis of CD-ROM algorithm
While the algorithm in question (Figure 3)¹ identifies airway obstruction as a reduction in the ratio of forced expiratory volume in 1 second (FEV₁) to forced vital capacity (FVC) before bronchodilator challenge, there is no mention of the postbronchodilator FEV₁-FVC ratio. As a result, a spirometric diagnosis of COPD cannot be established without an unprompted search for the postbronchodilator FEV₁-FVC ratio measurement by the person interpreting the spirometry tests.

A spirometric diagnosis of acute airway obstruction (assuming the ratio returns to normal) is also difficult to obtain without an unprompted search by the person interpreting the tests. Because the algorithm should serve as a stand-alone document, the absence of a logic string linked to the postbronchodilator FEV₁-FVC ratio limits its usefulness, particularly because some clinicians might not be familiar with the spirometric criteria for COPD diagnosis.

In the interactive CD-ROM, reversibility is defined as an improvement in the prebronchodilator FEV₁ value (that had been below normal levels) by 12% and 180 mL after β₂-agonist challenge. This definition is used to guide the user to suspect either asthma or COPD; COPD is suspected if the reversibility criterion is not met. There are 2 problems with this approach: current COPD guidelines require a reduction in the postbronchodilator FEV₁-FVC ratio for diagnosis, and changes in FEV₁ after bronchodilator challenge are not included in the spirometric diagnostic criteria for COPD.³ It is well established that most patients who meet the spirometric diagnosis of COPD also meet the FEV₁ reversibility criteria outlined in the algorithm and in asthma.

This article has been peer reviewed.
Cet article a fait l’objet d’une révision par des pairs.
Can Fam Physician 2011;57:1153-6
management guidelines. Given the phenotypic overlap between asthma and COPD, the current algorithm could lead the user to suspect asthma in many cases of COPD.

Relevance to family physicians

Spirometry provides the only simple, office-based objective test to distinguish between asthma and COPD. Guidelines on asthma management recommend an increase of 12% and of at least 200 mL in the FEV₁ after bronchodilator challenge to support a diagnosis of asthma. A spirometric diagnosis of COPD is suspected when the FEV₁-FVC ratio remains consistently below 0.70 after bronchodilator challenge. A spirometry interpretation algorithm should allow physicians to determine whether patients meet spirometric criteria for asthma or COPD or both and should recognize that spirometry alone cannot confirm a clinical diagnosis.

Application to clinical practice

Four brief spirometry cases, all meeting American Thoracic Society criteria for acceptability and reproducibility, highlight how the algorithm could influence interpretation of the spirometric data.

Case 1. The prebronchodilator and postbronchodilator FEV₁-FVC ratios are 0.79 and 0.82, respectively (Figure 2 on page 1151). The CD-ROM algorithm (Figure 3) would consider the prebronchodilator FEV₁-FVC ratio normal and would not indicate a bronchodilator challenge test. A newly proposed algorithm (Figure 1 on page 1149) would recommend bronchodilator challenge despite a normal FEV₁-FVC ratio, revealing an improvement in FEV₁ from 2.92 to 3.29 L (increase of 370 mL and 13%). The new algorithm indicates that these data are consistent with asthma given the improvements in FEV₁ after bronchodilation. The patient in this case was a 45-year-old man who had never been a smoker.

Figure 3. Diagnostic flow diagram for obstruction from the Ontario Lung Association’s CD-ROM

COPD—chronic obstructive pulmonary disease, FEV₁—maximal volume of air exhaled after a maximal inhalation in the first second of a forced exhalation, FVC—maximal volume of air exhaled after inhalation during forced exhalation, PFT—pulmonary function test.

Reprinted from the Ontario Lung Association.
Limitations of a spirometry interpretation algorithm

Case 2. The prebronchodilator and postbronchodilator FEV₁-FVC ratios are 0.48 and 0.50, respectively (Figure 2 on page 1151). The prebronchodilator and postbronchodilator FEV₁ results are 1.52 and 1.88 L, respectively (increase of 360 mL and 24%). The CD-ROM algorithm would consider the reduction in prebronchodilator FEV₁-FVC ratio as possibly being related to a combined defect of obstruction and restriction or hyperinflation because the FVC is also reduced (Figure 4). Given that the FVC improved and the FEV₁ increased with use of a β₂-agonist (according to reversibility criteria), the user is led to suspect asthma. The new algorithm recognizes the reduction in FEV₁-FVC ratio before bronchodilator use, but the postbronchodilator FEV₁-FVC ratio is evaluated to determine whether there is a combined defect of obstruction and restriction or hyperinflation. Given that the FVC increased to more than 80% of the predicted value with bronchodilation, it becomes clear that hyperinflation contributed to the reduced prebronchodilator FVC measurement. Because the postbronchodilator FEV₁-FVC ratio remains below 0.70 and the FEV₁ reversibility criterion is met, the clinician is led to differentiate asthma from COPD using historical data. The patient in this case is a 73-year-old man with a 40-pack-year smoking history, no allergies to environmental factors, and a history of progressive shortness of breath over the past 10 years. The medical history and family history were otherwise unremarkable for asthma risk factors. The historical and spirometric data in this case are consistent with a clinical diagnosis of COPD.

Case 3. The prebronchodilator and postbronchodilator FEV₁-FVC ratios are 0.47 and 0.50, respectively (Figure 2 on page 1151). The prebronchodilator and postbronchodilator FEV₁ values are 1.65 and 1.94 L, respectively (increase of 290 mL and 18%). The CD-ROM algorithm guides the clinician to consider a pure obstruction because the prebronchodilator FEV₁-FVC ratio is reduced and the FVC measurement is normal (Figure 3). The reversibility in FEV₁ leads one to suspect asthma. The new algorithm recognizes the reduced FEV₁-FVC ratio and the reversibility in FEV₁ after bronchodilation and guides the clinician to differentiate asthma from COPD on the basis of historical factors as well. The patient in this case is a 36-year-old woman who has never been a smoker. She has numerous environmental allergies and has severe asthma that is well controlled with maintenance therapy. Cases 2 and 3 highlight the spirometric overlap between asthma and COPD and the limitations of using FEV₁ reversibility to help distinguish asthma from COPD.

Case 4. The prebronchodilator and postbronchodilator FEV₁-FVC ratios are 0.64 and 0.78, respectively (Figure 2 on page 1151). The prebronchodilator and postbronchodilator FEV₁ values are 2.17 and 2.74 L, respectively (increase of 570 mL and 26%). The CD-ROM algorithm guides the clinician to consider a pure obstruction based on the reduced prebronchodilator FEV₁-FVC ratio and the normal prebronchodilator FVC value. The increase in FEV₁ meets the reversibility criterion and the clinician is led to suspect asthma. The new algorithm quickly excludes a spirometric diagnosis of COPD on the basis of the normal postbronchodilator FEV₁-FVC ratio, and the increase in FEV₁ would be consistent with a spirometric diagnosis of asthma. This case underscores the importance of using the postbronchodilator FEV₁-FVC ratio to quickly exclude COPD. The patient in this case is a 19-year-old man with a history of childhood asthma and β₂-agonist use increasing over several months. The algorithm in question lacks a logic string linked to the postbronchodilator FEV₁-FVC ratio, making it impossible to confirm a spirometric diagnosis of COPD on the basis of current guidelines. The focus on changes in FEV₁ after bronchodilator challenge to separate asthma from COPD could result in disease misclassification given the substantial phenotypic
Critical Appraisal | Limitations of a spirometry interpretation algorithm

Figure 4. Diagnostic flow diagram for restriction from the Ontario Lung Association's CD-ROM

![Diagnostic Flow Diagram For Restriction](image)

FEV$_1$ – maximal volume of air exhaled after a maximal inhalation in the first second of a forced exhalation, FVC – maximal volume of air exhaled after inhalation during forced exhalation, PFT – pulmonary function test.

Reprinted from the Ontario Lung Association. 1

Dr D’Urzo is Associate Professor, and Drs Jhirad and Tamari are Lecturers, all in the Department of Family and Community Medicine at the University of Toronto in Ontario. Dr Bouchard is Associate Professor of Clinical Medicine at Laval University. Head of the Department of Medicine at Centre hospitalier de la Malbaie, and a family physician in La Malbaie, Que. Dr Jugovic is Lead Hospitalist in the Department of Family Practice at Toronto East General Hospital. All authors are members of the Primary Care Working Group of the Primary Care Respiratory Alliance of Canada.

Acknowledgment
We thank Deborah D’Urzo, Devra D’Urzo, and Vasant Solanki for their valuable assistance in preparing this manuscript.

Competing interests
None declared

References

overlap between these 2 diseases. Further, the exclusion of bronchodilator challenge in patients with a normal FEV$_1$-FVC ratio in the algorithm in question could translate into a missed opportunity for asthma diagnosis and to undertreatment. The limitations outlined above are addressed in a new algorithm described in an accompanying paper (page 1148). 6