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Ask the Expert: Lung function measurement

M. Agnew

Respiratory Laboratory
St James's Hospital
James's Street
DUBLIN 8
Ireland
E-mail: magnew@stjames.ie

Competing interests
None declared.

Q **1. At present, we always use nose-clips when undertaking pulmonary function tests such as interrupter resistance (Rint) and spirometry on children. However, many children either really dislike this, or have small noses such that the clip slips off. Should we carry on using them routinely, and what are the advantages and disadvantages of using or not using nose-clips?**
E. Wooler, Brighton, UK

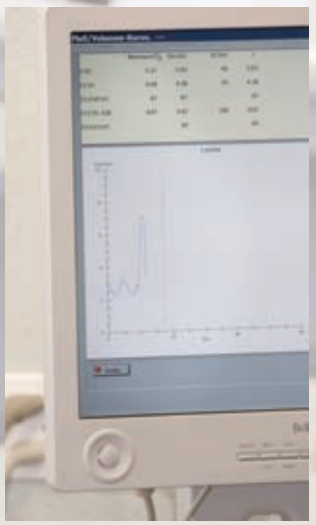
A 1. According to the 2005 American Thoracic Society (ATS)/European Respiratory Society guidelines [1], "the use of a nose-clip or manual occlusion of the nares is recommended...". This refers to spirometry. Previous guidelines stated that for "dynamic" tests, a nose-clip was not necessary, as there should be little time-delay from maximal inspiration to insertion of the mouthpiece and maximal exhalation to end-expiration; however, in practice, this is not always the case.
My opinion is that the use of nose-clips rules out air leak from the nose, which may not be apparent to the operator, and which may cause underestimation of measured values. It also prevents the patient from taking a second inspiration through the nose in the middle of a test, and thus giving inaccurate forced vital capacity (FVC) values.
Some of my colleagues who routinely test children often make a game of the child holding their own nose while doing the test, and so it becomes more fun than uncomfortable hospital rules! This can be done, provided the child keeps his elbows at his side and not raised; alternatively, ask a parent to do it. I think the advantages outweigh the disadvantages.

Q **2. On several occasions, I have come across patients who complain of breathlessness and who seem to have normal forced expiratory volume in 1 s (FEV_1), FVC and normal ratios, but have a very low forced midexpiratory flow (FEF_{25-75}). How would you interpret this isolated abnormality on spirometry when the patient is symptomatic (breathless)? Should it be treated, followed up or ignored ?**
As we know that this parameter indicates small airway obstruction, can we use it serially to assess patients with bronchiolitis (*i.e.* diagnosis and response to therapy)?
H. Dumra, Ahmedabad, India

Q **3. Is it possible to obtain reliable information regarding the status of the small airways? Are changes in the small airways due to treatment significant?**
D. Stav, Zerifin, Israel

Q **4. If FEF_{25-75} is low but other values are normal, should we interpret this as small airway obstruction? What is the cut-off value below which it can be said to be abnormal?**
M. Sarkar, Kangra, India

Q **5. a) Do we still need to carry out post-bronchodilator reversibility testing? b) What is the significance of isolated reduction in forced expiratory flows at 25%, 50% and 75% of full exhalation and in FEF_{25-75}, with normal FEV_1 and FVC? Would it indicate small airways obstruction?**
D. Patel, Vadodara, India



A 2-5. FEF_{25-75} is a derived index and is the mean expiratory flow between 25-75% of FVC. It requires maximal effort from the patient and is highly variable. It relies on the validity of the FVC manoeuvre and the level of expiratory flow. On report printouts, the value is taken from the blow with the largest sum of FEV_1 and FVC, and may not be the largest achieved. FEF_{25-75} must be measured with an accuracy of at least ±5%, or ±0.200 L per s, whichever is greater [1]. Abnormalities in these mid-range flow measurements during forced expiration are not specific for small airway disease in individual patients [2].
If a patient is particularly breathless when carrying out this test, although they may have normal FEV_1 and FVC, there may be reduced flows in the middle and latter stages of the manoeuvre due to tiredness, which will result in low FEF_{25-75}. Also, patients who are smokers or who have previously smoked, or those who have worked in an environment with noxious substances, may have some residual tissue damage from exposure, and this should be taken into consideration.
If you are concerned about the patient, then you should carry out further lung function tests *e.g.* lung volumes and gas transfer, to get a better overall picture of lung function.
We are told to "resist using FEF_{25-75} as a measure of small airways disease in individuals" [3]. ATS standards do not endorse FEF_{25-75} for diagnosing small airways disease and offer no way to use pulmonary function tests to diagnose small airways disease in an individual [4]. FEV_1 should be the index of choice when monitoring change in spirometric function, as it is the most repeatable, and the one that measures change in both obstructive and restrictive lung disease [2].
With regard to bronchodilator testing, will the results of the test change your prescribing? From experience, anaesthetists like to know "how good can this patient be?" prior to administration of anaesthetic, and request routine bronchodilator testing to decide whether the patient needs bronchodilation prior to surgery. In undiagnosed, symptomatic asthmatics, simple spirometry with bronchodilator testing will confirm a reversible element to their disease. In chronic obstructive pulmonary disease (COPD) patients, testing with simple spirometry and short/mid-acting bronchodilators is unlikely to produce much useful information. However, carrying out body plethysmography to measure airways resistance at rest, and post bronchodilator or trial of steroids, may indicate some element of reversibility in these patients. Unfortunately there is still no absolute verdict on whether bronchodilator testing is necessary: more research needs to be done.

Q **6. There is a persistent problem with primary care spirometry and its value, or otherwise. "Good" primary care with motivated and trained staff gives consistent and reliable results that we can depend on, but a significant number of professionals in secondary care refuse to pay heed to spirometry from primary care, indicating that reliable and relevant lung function testing can only be done in a lung function testing laboratory. Do you believe there is a genuine place for primary care spirometry, or should we all stop pretending?!**
I. Williams, Cambridgeshire, UK

A 6. I would be of the opinion that there definitely is a place for primary care spirometry, particularly with the increasing numbers of elderly respiratory patients needing follow-up or continuing care. I do feel, however, that newly diagnosed patients should be assessed fully in a lung function lab to get accurate baseline evaluation of function. Regular follow-up can then be undertaken locally by the patient's general practitioner. In primary care it is important that: a) the operator is fully trained to carry out spirometry; and b) that the equipment is well maintained and calibrated to ensure the accuracy of test results.

Q **7. What are your views on the use of the standard deviation (SD) as opposed to % predicted? Should we adopt the former?**
K. Carter, Elrick, UK

A 7. Historically, % pred has been, and in many areas still is, the recognised way of presenting measured lung function parameters. Reference equations are available to predict expected lung function results for individuals, taking into account age, height, sex and ethnicity. These equations quote the various coefficients for age and height and also the residual SD (RSD; standard error of the estimate) for the prediction. This latter number is sex-specific and is used to derive the deviation from predicted value as standardised residuals (SR) [5], where SR=(recorded-predicted)/RSD. These SR values are

dimensionless and indicate how many SD the subject's result is from predicted.
To obtain the reference range, we need to know how many SD away from the mean we need to go to include 90% of the population [6]. This will leave 5% at the top end of the range and 5% at the bottom end of the range. One SD will include 68% of the population, and 2 SD will include 95% of the population. The multiple of SD to cover 90% of the population is 1.645. So for a conventional 90% lower confidence limit, an SR value more negative than -1.645 means the index is abnormal [6]. You should therefore select SR (possibly alongside % pred) for your report printout, and a quick look at SR results that are more negative (smaller) than -1.645 will tell you if there is an index in the 'abnormal' range.
Using a more simplistic measure *e.g.* ±20% of the predicted value, as a "normal" range works reasonably well for patients of average height and age, but tends to fail with subjects outside the average, and the failures worsen as distance from the average increases [3].
Using % pred is not the correct way to determine whether a result is abnormal [7], since the cut-off value that determines abnormality varies between spirometric indices and with sex, age and height of subjects, so a single value of % pred is never correct in determining whether the subject is abnormal.
It may be difficult to change from % pred, but by reporting the SR values alongside the % pred at first, staff will become used to interpreting a more realistic evaluation.

Q 8. What is the importance of forced expiratory volume in 6 s (FEV_6) in the diagnosis of obstructive pattern?
S. Pecho Silva, Lima, Peru

A 8. Advocates of FEV_6 as a substitute for FVC will tell you that it is more reproducible than FVC in COPD patients and reduces the effort required by patients. However, from experience, these patients can sometimes take up to 15–20 s to exhale fully, and the difference between the true FVC value and FEV_6 can be substantial in patients with severe flow limitation. Increasing the FVC to its measured value may reduce the FEV_1/FVC ratio, so by taking FEV_6 as the vital capacity (*i.e.* measuring FEV_1/FEV_6), you may underestimate the level of obstructive lung disease. More research needs to be done to truly assess the usefulness of FEV_6.

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Ask the Expert - Clinical Dilemmas in Asthma

In the next issue of *Breathe*, to be published in June, Dr Mina Gaga, of the Athens Chest Hospital, Athens, Greece, will answer readers' questions on the subkect of clinical dilemmas in asthma. In addition to her clinical and research work, Dr Gaga is secretary of the European Board for Accreditation in Pneumology and has served as director of learning resources for the European Respiratory Society School.

Dr Gaga cannot enter into direct correspondence with readers or answer questions about specific cases. Questions with wider relevance to common problems are most likely to be selected.
Please send your questions to breathe@ersj.org.uk by Monday, April 13, 2009.