Quality assessment pathway for respiratory oscillometry

Received: 22 Sept 2021
Accepted: 19 Jan 2022

To the Editor:

There is strong evidence to support the addition of respiratory oscillometry to standard lung function testing. The key parameters are sensitive in identifying the presence and severity of airways disease [1], and clinically meaningful cut-offs have been established to identify bronchodilator response [2] and bronchial hyperresponsiveness [3–6] independent of spirometry. While clinical uptake is increasing with the availability of commercial devices, oscillometry is yet to be widely adopted as a standard test. This has been in part due to a lack of standardisation in equipment specifications and inconsistent terminology, but also human-related factors such as measurement protocols and objective quality control. The recently published international technical standards [7] have partly addressed most of these issues, and the development of global reference equations is currently in progress. Nevertheless, there remains a strong need to develop standard methods to optimise measurement quality and operator competency.

Operator oversight, feedback and frequency of testing is known to significantly improve spirometry quality [8]. Although oscillometry measurements are collected during resting tidal breathing, it is a misconception that less quality control surveillance is required in comparison to forced manoeuvres. We present a quality assessment pathway based on current technical standards for oscillometry [7], established frameworks for spirometry [9], and over 10 years' experience with clinical oscillometry testing (figure 1). Similar to other tests of lung function, ideal levels of test quality are not always achievable; thus, we propose a quality grading system based on technical acceptability and within-session coefficient of variability (CoV). The grades range from the best quality achievable that offers the highest level of confidence, to the minimum quality that may still provide clinical utility.

In preparation for the test, the technical standards recommend daily verification using an appropriate test load and also provide a list of minimum instructions for patients prior to testing [7]. In the measurement phase, the goal is to obtain at least three technically acceptable individual trials (or "replicates"). While not specified in the technical standards, we suggest that no more than eight trials be collected, consistent with spirometry [9] and the observation that a plateau for CoV is usually reached at this point [10].

Grading is applied in the post-processing phase and is dependent on the number of technically acceptable trials achieved and within-session CoV of resistance at 5 Hz (R_5). The highest quality grading, A, represents the current technical standards recommendation of at least three acceptable trials with a CoV $\leqslant$10% [7]. However, there is increasing evidence that higher within- and between-session variabilities are inherent to airways disease, unaffected by the number of trials completed. The 95th centiles for within-session CoV for asthma and COPD during stable disease reach up to 13% and 18%, respectively [10]. Thus, we assign 15% and 20% CoV as grades B and C, respectively. Grades D and E represent scenarios where either variability is further increased, or the recommended number of technically acceptable trials is not attained. For grade D, our suggested upper CoV limit of 40% is based on our analysis of previous data collected during exacerbations of COPD [11], where we calculated the 95th percentile for CoV as 40.6%. This should be re-evaluated when further evidence is available. We suggest that grades D and E still be reportable but flagged, and grade F (when the above criteria are not met) be unreportable.

Importantly, within-session CoV is not considered for individual trial acceptability, but rather for final quality grading. This eliminates operator bias, where trials may be spuriously chosen to reduce CoV.

Shareable abstract (@ERSpublications)
A flow-chart-driven procedure is presented to facilitate respiratory oscillometry operator competency and measurement quality. A novel feature is a quality grading system, in line with other standards of lung function. https://bit.ly/3G4r0X1

Cite this article as: Cottee AM, Thamrin C, Farah CS, *et al*. Quality assessment pathway for respiratory oscillometry. *ERJ Open Res* 2022; 8: 00569-2021 [DOI: 10.1183/23120541.00569-2021].

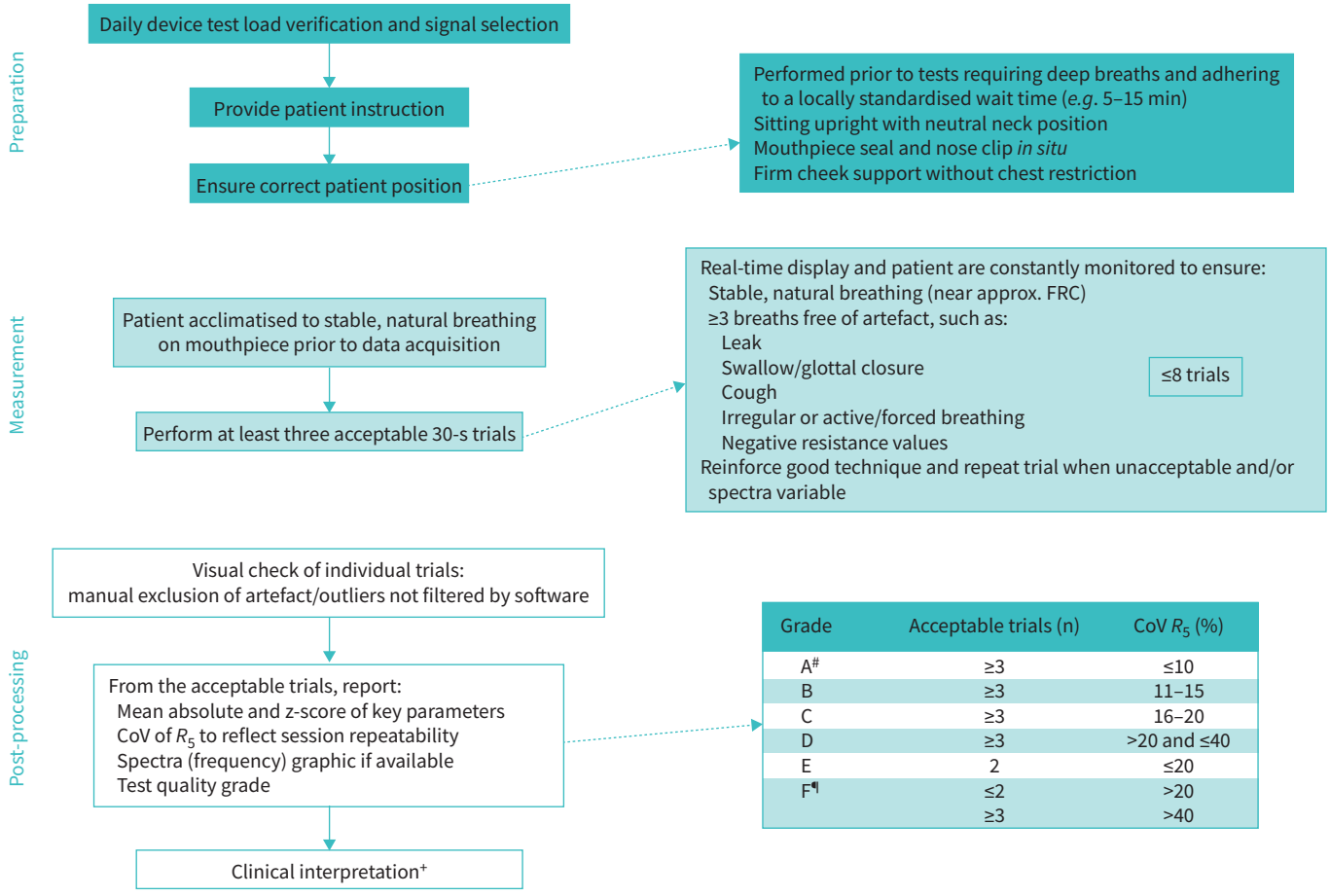

FIGURE 1 Quality assessment pathway for respiratory oscillometry. #: standard quality session; ¶: unreportable; +: grade D and E to be interpreted with caution. FRC: functional residual capacity; CoV: coefficient of variation (for ⩾2 trials); R_5: resistance at 5 Hz.

Careful vetting focusing on technical acceptability rather than CoV at the end of each trial allows the opportunity to modify patient instruction to improve technique, if required.

We have only incorporated the within-session CoV for R_5 for quality assurance, as per the technical standards. Although the upper limits of reactance have been published in health and disease, CoV of reactance can be highly variable and difficult to interpret owing to its proximity to zero, thus may not be suitable as a quality control measure. Examination of the frequency spectra may also allow the operator to compare impedances of individual trials across frequencies to assess outlying trials. However, this feature is not universally available, nor is it applicable to single-frequency systems.

This pathway and grading system is proposed for use within the clinical or research laboratory setting. It is worth noting that for home telemonitoring or field applications, the technical standards allow for the measurement of a single, longer recording. In such cases, other quality control measures may need to be applied, *e.g.* the within-trial variability. In addition, the recommended cut-off for within-session CoV for children is higher (15%), and the effect of disease on variability relatively unclear. Hence, the present framework can only be recommended for adults.

Our proposal to report testing quality for respiratory oscillometry using a standardised, regimented pathway and grading system aims to operationalise the ideal recommendations set out in the technical standards. It serves as a framework for operator training, compliance, and standardised assessment with feedback, which is known to improve lung function session quality in general. Validation studies are now required to assess the utility of this pathway across clinical and primary care laboratories, and broad community groups.

Alice M. Cottee [1,2,3], Cindy Thamrin [2,3], Claude S. Farah [1,2,3] and Leigh M. Seccombe [1,2]

[1]Dept of Thoracic Medicine, Concord Repatriation General Hospital, Sydney, Australia. [2]Faculty of Medicine and Health, The University of Sydney, Sydney, Australia. [3]Woolcock Emphysema Centre and Airway Physiology and Imaging Group, Woolcock Institute of Medical Research, Sydney, Australia.

Corresponding author: Leigh M. Seccombe (leigh.seccombe@sydney.edu.au)

Provenance: Submitted article, peer reviewed.

Conflict of interest: C. Thamrin reports receiving grants or contracts from Restech SRL, Milan, Italy (intellectual property contract and clinical trial agreement); and reports receiving equipment, materials, drugs, medical writing, gifts or other services from Restech SRL, THORASYS Thoracic Medical Systems and NDD technologies, Switzerland/ Niche Medical, Australia (equipment loaned for research studies); all disclosures made outside the submitted work. C.S. Farah reports receiving payment or honoraria for lectures, presentations, speaker bureaus, manuscript writing or educational events from AstraZeneca, Boehringer Ingelheim, Chiesi, GlaxoSmithKline and Sanofi Genzyme, outside the submitted work. The remaining authors have nothing to disclose.

References

1 Cavalcanti JV, Lopes AJ, Jansen JM, *et al.* Detection of changes in respiratory mechanics due to increasing degrees of airway obstruction in asthma by the forced oscillation technique. *Respir Med* 2006; 100: 2207–2219.
2 Cottee AM, Seccombe LM, Thamrin C, *et al.* Bronchodilator response assessed by the forced oscillation technique identifies poor asthma control with greater sensitivity than spirometry. *Chest* 2020; 157: 1435–1441.
3 Seccombe LM, Peters MJ, Buddle L, *et al.* Exercise-induced bronchoconstriction identified using the forced oscillation technique. *Front Physiol* 2019; 10: 1411.
4 Bouaziz N, Beyaert C, Gauthier R, *et al.* Respiratory system reactance as an indicator of the intrathoracic airway response to methacholine in children. *Pediatr Pulmonol* 1996; 22: 7–13.
5 Mansur AH, Manney S, Ayres JG. Methacholine-induced asthma symptoms correlate with impulse oscillometry but not spirometry. *Respir Med* 2008; 102: 42–49.
6 Evans TM, Rundell KW, Beck KC, *et al.* Impulse oscillometry is sensitive to bronchoconstriction after eucapnic voluntary hyperventilation or exercise. *J Asthma* 2006; 43: 49–55.
7 King GG, Bates J, Berger KI, *et al.* Technical standards for respiratory oscillometry. *Eur Respir J* 2020; 55: 1900753.
8 Schneider I, Rodwell L, Baum S, *et al.* Assessing spirometry competence through certification in community-based healthcare settings in Australia and New Zealand: a position paper of the Australian and New Zealand Society of Respiratory Science. *Respirology* 2021; 26: 147–152.
9 Graham BL, Steenbruggen I, Miller MR, *et al.* Standardization of Spirometry 2019 Update. An official American Thoracic Society and European Respiratory Society technical statement. *Am J Respir Crit Care Med* 2019; 200: e70–e88.
10 Harkness LM, Patel K, Sanai F, *et al.* Within-session variability as quality control for oscillometry in health and disease. *ERJ Open Res* 2021; 7: 00074-2021.
11 Jetmalani K, Timmins S, Brown NJ, *et al.* Expiratory flow limitation relates to symptoms during COPD exacerbations requiring hospital admission. *Int J Chron Obstruct Pulmon Dis* 2015; 10: 939–945.