Editorial

Second hand smoke and oscillometry Omnia cum pretio (Everything with a price)

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Oscillometry (also known as the forced oscillation technique) measures the mechanical properties of the respiratory system (upper and intrathoracic airways, lung tissue and chest wall) during quiet tidal breathing, by the application of an oscillating pressure signal (input or forcing signal), most commonly at the mouth. Physiologically oscillometry is fundamentally a different measurement to traditional lung function measurements, *i.e.* spirometry and lung volumes, single breath diffusion (DLCO), specific airways conductance (sGAW) and usually compliments them.[1-3]

Although thresholds for positive bronchodilatation have been established (-40% Rrs,+50% Xrs,-80% AX), z-scores are recommended for future definition of a significant response,[1] along with an effect size that is a measure that tells you how important a difference is. The method has potential sources of error (patient breathing, bacterial filters, artificial airways) and verification (reactive test load has not been established).[4]

Nevertheless, oscillometry can be used in various clinical settings which include clinical lung function laboratories, field testing, home monitoring and intensive care. Oscillometry measurements have mostly been applied in airways diseases and paediatric lung diseases, where oscillometry may have the most widespread clinical application. The short testing times and ease of administration for subjects are potential advantages in this setting.

In this issue of the journal, *Kairi et al,*[5] show that acute exposure of healthy non-smokers to second-hand smoke (SHS) leads to alterations of resting breathing mechanics suggestive of a likely broncho-constrictive response to the irritative inhalant, successfully captured by impulse oscillometry (IOS). The authors used the IOS system by Jaeger which in relation to forced oscillation pseudorandom technique causes harmonic distortion and waveforms that induce large volume fluctuations in relation to the underlying breathing volume, especially when the respiratory system behaves in a substantially nonlinear fashion, *i.e.* in the presence of severe airflow obstruction or cyclic lung recruitment and derecruitment.[6] The authors for the first time report on early lung pathology detected by IOS caused by SHS (early not mild COPD), and since pre-post measurements were performed with the same apparatus, with the same technique on the same subject, bias is minimized (coherence function not reported).

Coherence is another important parameter and is used to determine

the validity and quality of the test results. It reflects the reproducibility the impedance measurements. It is a value between 0 and 1 and, ideally, should be >0.8 at 5 Hz and >0.9 at 20 Hz for the measurement to be considered valid. However, it is important to note that these values are for adults, and there are no standard values reported in children. Coherence can be decreased because of improper technique, irregular breathing, glottis closure, and swallowing.[7]

Tobacco smoke contains thousands of xenobiotics harmful to human health. Their irritant, toxic and carcinogenic potential has been well documented. Passive smoking or exposure to SHS in public places, including workplace, poses major medical problems. In a Greek study,[8] a 1-h exposure to SHS levels at bar/restaurant significantly increased the white blood cells (WBC) for at least 4 h following the exposure time. This effect of SHS on WBC has dose-response characteristics and should be considered to prescribing complete blood count.

In another study,[9] several xenobiotic metabolizing genes especially the EPHX1 (epoxyl hydrolase) low activity diplotype with additional effect modifiers CYP1A1 and GSTT1 (glutathione S tranferase T1) may modify the impact of second-hand tobacco smoke and ambient air pollutants, polycyclic aromatic hydrocarbons and PM2.5, on acute bronchitis in preschool children. Also, short-term cigarette smoke exposure predisposes the lung to secondary injury (second hit).[10]

Following the 2006 legislation (banning smoking in all public places in Scotland), asthma admissions decreased in both younger children (-0·36% [-0·67 to -0·05], p=0·021) and older children (-0·68% [-1·00 to -0·36], p<0·0001), and in children from the most deprived (-0·49% [-0·87 to -0·11], p=0·011) and intermediate deprived (-0·70% [-1·17 to -0·23], p=0·0043) area quintiles, but not in those from the least deprived area quintile.[11]

The recent outbreak of the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which causes coronavirus disease 2019 (COVID-19), has led to a worldwide pandemic. Both acute and second-hand smoke were found to increase ACE2 expression in the bronchus with Inhaled corticosteroids decreasing ACE2 expression in the lower airways. No significant effect of genetics on ACE2 expression was observed, but a strong association of DNA- methylation with ACE2 and TMPRSS2- (serine protease) mRNA expression was identified in the bronchus,[12] emphasizing the impact of SHS.

In a COPD study, early intervention triggered by worsening of oscillometric indices was not associated with any differences in hospitalisation, or symptoms. However, there was a significant reduction in repeat hospitalisations, leading to significantly reduced healthcare costs.[13] Self-reported chronic bronchitis or emphysema or COPD was associated with higher pulmonary resistance and lower pulmonary reactance measured by IOS, both among subjects with and without COPD according to GOLD criteria. IOS may have the potential to detect pathology associated with COPD earlier than spirometry.[14]

Impulse oscillometry parameters demonstrated greater sensitivity compared with spirometry for monitoring reversibility of airway obstruction and the effect of maintenance therapy. Impulse oscillometry may facilitate early treatment dose optimization and personalized medicine for chronic obstructive pulmonary disease patients.[15]

Small airway wall area percentage (Aw% 7-9), an EB-OCT (endobronchial optical coherence tomography) parameter, correlated significantly with Fres (resonant frequency) and R5-R20 (difference in resistance between 5 and 10 Hz) in early COPD, but not spirometry.[16]

The cut-offs for small airway disease are difference in resistance at 5 Hz and resistance at 20 Hz greater than 0.07 kPa/(L/s), reactance at 5 Hz less than -0.12 kPa/(L/s), Fres greater than 14.14 Hz, and area under reactance curve between 5 Hz and resonant frequency greater than 0.44 kPa/L.[17]

The reported values although did not reach these thresholds, were statistically significant and show that even short exposure acute effects of SHS are detrimental on lung health, particularly if exposure is intermittent and repetitive.

CONFLICT OF INTEREST
None

REFERENCES

1. King GG, Bates J, Berger KI, et al. Technical standards for respiratory oscillometry. Eur Respir J 2020; 55:1108-14.
2. Thamrin C. Dellacà Raffaele L, Hallet GL, et al, on behalf of the authors of the ERS technical standards for respiratory oscillometry. Technical standards for respiratory oscillometry: test loads for calibration and verification. Eur Respir J 2020; 56:2003369.
3. Panagou P, Bouros E, Tzouvelekis A, Tzilas V, Bouros D. Lung function in the elderly: Nascentes morimur Pneumon 2018; 31(1):14-6.
4. Τζώρτζη ΆΣ, Λάππας ΑΣ, Κωνσταντινίδη ΕΜ, Τελωνιάτη ΣΙ, Τζαβάρα ΧΚ, Μπεχράκης ΠΚ. Κάπνισμα ναργιλέ: άμεσες επι-

δράσεις στον τύπο της αναπνοής, στην κεντρική αναπνευστική ώση και στη μηχανική της ήρεμης αναπνοής σε υγιείς νεαρούς ενήλικες Πνεύμων 2018; 31(3):151-8.
5. Kairi O, Kapetanstrataki M, Lymperi M, Behrakis P, Tzortzi A. Immediate effects of SHS on the mechanics of tidal breathing. Pneumon 2020; 33(3):118-30.
6. Hellinckx J, Cauberghs M, De Boeck K, et al. Evaluation of impulse oscillation system: comparison with forced oscillation technique and body plethysmography. Eur Respir J 2001; 18:564-70.
7. Hwa-Yen Chiu , Yi-Han Hsiao , Kang-Cheng Su , et al. Small airway dysfunction by impulse oscillometry in symptomatic patients with preserved pulmonary function. J Allergy Clin Immunol Pract 2020; 8:229-35.
8. Dinas PC, Metsios GS, Jamurtas AZ, et al. Acute effects of second-hand smoke on complete blood count. Int J Environ Health Res 2014; 24:56-62.
9. Ghosh R, Topinka J, Joad J, et al. Air pollutants, genes and early childhood acute bronchitis. Mutat Res 2013; 749:80-6.
10. Bhavsar T, Cerreta JM, O Cantor J. Short-term cigarette smoke exposure predisposes the lung to secondary injury. Lung 2007;185:227-33.
11. Turner S, Mackay D, Dick S, et al. Associations between a smoke-free homes intervention and childhood admissions to hospital in Scotland: an interrupted time-series analysis of whole-population data. Lancet Public Health 2020; 5:e493-e500.
12. Aliee H, Massip F, Qi C, et al. Determinants of SARS-CoV-2 receptor gene expression in upper and lower airways medRxiv 2020. Doi: org/10.1101/2020.08.31.20169946. preprint
13. Walker PP, Pompilio PP, Zanaboni P, et al. Telemonitoring in chronic obstructive pulmonary disease (CHROMED). A randomized clinical trial. Am J Respir Crit Care Med 2018; 198:620-8.
14. Frantz S, Nihlén U, Dencker M, et al. Impulse oscillometry may be of value in detecting early manifestations of COPD Respir Med 2012; 106:1116-23.
15. Saadeh C, Saadeh C, Cross B, et al. Advantage of impulse oscillometry over spirometry to diagnose chronic obstructive pulmonary disease and monitor pulmonary responses to bronchodilators: An observational study. SAGE Open Med 20156; 3:2050312115578957.
16. Zhu-Quan Su , Wei-Jie Guan , Shi-Yue Li , et al. Significances of spirometry and impulse oscillometry for detecting small airway disorders assessed with endobronchial optical coherence tomography in COPD. Int J Chron Obstruct Pulmon Dis 2018; 13:3031-3044.
17. Desiraju K, Agrawal A. Impulse oscillometry: The state-of-art for lung function testing. Lung India 2016; 33:410-6.