129 Shortened SF_6 MBW is a repeatable and sensitive test in adults and children with CF

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Introduction: Lung Clearance Index (LCI) derived from SF_6 multiple breath washout (MBW) is a sensitive measure of lung disease. However it can be time-consuming, limiting its clinical use.
Aim: To compare the repeatability and sensitivity of LCI until $1/40^{th}$ of starting concentration (LCI_{40}) to a shorter version of LCI until $1/20^{th}$ of starting concentration (LCI_{20}).
Methods: Triplicate MBW test data from 30 stable CF patients and 30 healthy controls were selected from a larger prospective study. MBW tests were performed using 0.2% SF_6 and a modified Innocor^{TM}. LCI_{40} and LCI_{20} were calculated using SimpleWashout software. Repeatability was assessed using coefficient of variation (CV%). The proportion of CF patients with abnormal results was compared. LCI normal limits were determined from control mean+2SD. Receiver operating characteristic (ROC) curve statistics were calculated (1.0=accurate test).
Results: CV% of LCI_{40} and LCI_{20} was comparable and not significantly different to controls (Table 1). The sensitivity of LCI_{40}, LCI_{20} and FEV_1 was 67%, 63% and 47% respectively. Area under the ROC curve (95% CI) for LCI_{40}, LCI_{20} and FEV_1 were 0.87 (0.78–0.96), 0.87 (0.77–0.96) and 0.73 (0.60–0.86) respectively.

Table 1. Summary of CF and control data

	CF (n = 30)	Control (n = 30)	p-value
Mean (SD) age	20.7 (11.1)	20.8 (10.7)	0.93
Mean (SD) LCI40	8.9 (2.4)	6.4 (0.5)	<0.0001
CV%	5.2 (2.8)	4.3 (2.0)	0.20
Mean (SD) LCI20	6.6 (1.2)	5.2 (0.4)	<0.0001
CV%	5.7 (3.4)	4.6 (2.3)	0.26

Conclusions: LCI_{20} is a repeatable and sensitive test that is shorter than LCI_{40}, offering a more feasible clinical measure.
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130 Enhanced photoacoustic gas analyser (Innocor) for multiple breath washout. Improvements to analyser response time maintains accuracy at fast ventilation rates, and produces a system that meets all washout technology performance targets

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Objectives: The Innocor device contains a highly sensitive photoacoustic analyser which allows multiple breath washout (MBW) measurements using very low concentrations of the tracer gas SF_6. Previously, use in smaller subjects has been restricted by the need for an analyser response time <100 ms to ensure accurate estimation of lung volumes at rapid ventilation rates. Here we report the effect of response time improvements.
Methods: A series of previously reported and novel enhancements were made to the analyser to produce a clinically practical system with a reduced response time. An enhanced lung model was constructed delivering highly accurate ventilation rates and volumes. This was used to assess *in vitro* accuracy of volume calculation, and the effects of flow and gas signal alignment.
Results: 10–90% rise time was reduced from 154 to 88ms. In an adult/child lung model, accuracy of volume calculation was –0.9 to 2.9% for all measurements, including at a ventilation rate of 30/min and lung volume 0.5 L; for the un-enhanced system, accuracy deteriorated at higher ventilation rates and smaller lung volumes. In a separate small volume lung model (ventilation rate 60/min, lung volume 250 ml, tidal volume 100 ml), mean accuracy of volume calculation for the enhanced system was minus 0.95% (range –3.8 to 2.0%).
Conclusion: The Innocor analyser can be enhanced to reliably generate highly accurate lung volume measurements down at volumes as low as those simulating infant lung settings. Signal alignment is a critical factor. With these enhancements, Innocor achieves all of the recent technical recommendations for MBW apparatus, including those for accuracy in infant settings.

131 Multiple breath nitrogen washout in healthy children and adults: a comparison of two commercially available devices

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Background: Multiple breath nitrogen washout (MBWN2) is a promising tool in pediatric pulmonology. Data comparing recent commercially available devices are lacking.
Objective: To compare the results obtained from 2 such devices in healthy children and adults.
Methods: Healthy subjects were recruited to perform MBWN2 tests in duplicate using two devices (EasyOne Pro, NDD, Switzerland – Exhalyzer D, EcoMedics, Switzerland), in random order on the same session. Agreement between devices was assessed by Bland-Altman plot. In a subset of adults, FRC was also measured using helium dilution (FRC He).
Results: Acceptable values were obtained with each device in all subjects (51 adults: 21–58 y, 41 children: 5–17 y). Both devices were considered equally convenient by children and adults. Using a given apparatus, LCI values were similar in adults and children, which allowed to pool the data (n = 92). On average, LCI NDD was consistently lower than LCI EM (6.54±0.57 vs 6.94±0.42, $p < 0.001$; mean difference: –0.40, 95% CI: –1.59 to 0.79). EM yielded a narrower range of normal values ($p = 0.04$). The intraindividual CV was lower using EM than using NDD (2.9±2.6% vs 5.5±3.7%, $p < 0.001$). FRC NDD was lower than FRC EM (2.04±0.94 L vs 2.7±1.28 L; $p < 0.001$). FRC He was measured in 11 adults and corresponded to 100% (±6) of FRC EM and 81% (±7) of FRC NDD. When compared to FRC He, underestimation of FRC by NDD was significant ($p < 0.001$).
Conclusion: In normal subjects, LCI and FRC obtained using current versions of the EasyOnePro or the EcoMedics are not interchangeable. EcoMedics yields more reproducible LCI values, a narrower range of normal values and more accurate FRC measurements.

132 Improving the feasibility of multiple-breath nitrogen washout in cystic fibrosis adults

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Background: In CF, lung clearance index (LCI) measured by a multiple breath nitrogen washout (MBWN2) is time consuming in patients with advanced respiratory disease. Shortening the test would increase its feasibility.
Objective: To assess repeatability and diagnostic performance of LCI in CF adults, from two acceptable runs until $1/40^{th}$ ($LCI_{2.5}$, conventional test), $1/25^{th}$ (LCI_4) or $1/20^{th}$ (LCI_5) of starting N_2 concentration.
Methods: Retrospective analysis of MBWN2 tests performed in duplicate in adults with CF, using the Exhalyzer D (Ecomedics, Switzerland). Time to complete 2 measurements + between resting time (i.e. 1.5× washout time), diagnostic performance and repeatability were assessed for $LCI_{2.5}$, LCI_4 and LCI_5.
Results: Data from 34 CF adults were analysed (15 M, median age: 24.5 y, IQR: 21–32; mean±SD FEV1: 84.5±19.8% pr). Mean (SD) $LCI_{2.5}$ was 13.73 (3.63). Corresponding values for LCI_4 and LCI_5 were 9.52 (2.29) and 8.14 (1.83) respectively. Compared to $LCI_{2.5}$, repeatability of LCI_4 and LCI_5 were similar, but only the former had similar diagnostic performance and a predictive value (R^2) for $LCI_{2.5}$ >0.9 ($R^2 = 0.92$). Mean time needed to complete 2 LCI_4 measurements was 9.9 min *vs* 15.6 min for $LCI_{2.5}$ ($p < 0.001$, time saving: 38%). Restricting the analysis to the 6 patients with highest LCI (19.01±1.59; mean FEV1: 76% pr, range: 62–96), mean session duration decreased from 21.3 to 11.7 min (time saving: 45%).
Conclusion: In this study, LCI_4 appears to be a reliable and more feasible test in CF patients with moderate to severe lung disease.
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