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Slope indices from ultrasonic tidal molar mass-volume curves

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Simple yet sensitive tools for assessment of peripheral airway disease are urgently needed. The slope of the alveolar phase III obtained from capnography or gas washout has been shown to reflect changes in ventilation distribution not detected by conventional spirometry. An ultrasonic flowmeter (US) has the advantage that flow, volume and molar mass MM of the respired gas can be recorded.
We have performed a pilot study to assess the feasibility of calculating tidal slope indices using an US (Spiroson) both from mainstream (msMM) and sidestream molar mass (ssMM) signals.
Tidal breathing was recorded for 2 min prior to multiple breath washout on 12 occasions using the US. Expirograms were constructed by plotting MM against expired tidal volume and indices of ventilation distribution were calculated. The slope of phaseIII was normalized (SnIII). Expirograms from ssMM were similar to those seen in capnography. Calculation of SnIII was feasible for all measurements from both, msMM (1.33(0.79)) and ssMM (0.62(0.38)) and highly correlated (r^2=0.788). SnIII decreased with increasing tidal volume. Patients with obstructive lung disease had higher SnIII than controls.
msMM yields results different from ssMM because temperature and humidity are influencing the signal. However, calculation of slope indices was feasible. There was a trend for higher SnIII (msMM and ssMM) in more severe lung disease. These preliminary data suggest that ultrasonic tidal breathing analysis may become a clinically useful tool.
The project is supported by Mukoviszidose e.V.

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Improved system for ultrasonic measurement of functional residual capacity (FRC) and ventilation inhomogeneity (VI)

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Assessment of FRC and indices of VI by multiple breath washout (MBW) have been shown to provide important information about pathophysiology of different lung diseases. We have previously shown that an ultrasonic flowmeter (US, Spiroson®) can be adapted for application of MBW beyond infancy. However, there have been numerous problems with data acquisition and analysis.
Since then, the system was improved markedly by 1) introducing an additional side-stream US as a reference molar mass signal (ssMM), 2) using a pre-mixed gas with 4% SF6 as tracer gas, 3) introducing a valve for controlled gas delivery during the wash-in, and 4) extending the sampling time.
Preliminary analysis of 26 measurements in 20 subjects (age range 5-49 years) showed high stability of the end-inspiratory MM (EIMM) compared to the previous set-up; ssMM was more stable than mainstream MM (msMM), both, within and between measurements.
The uncorrected ssMM was visually comparable to a mass spectrometer signal with no apparent influence of temperature and humidity.
Analysis yielded similar results for msMM and ssMM.
In conclusion, we have demonstrated improved safety and validity for application of

ultrasonic MBW beyond infancy .
The project is supported by Mukoviszidose e.V.

EIMM	old set-up	ms	Ss
group mean	35.71	34.03	34.02
range	32.7-38.3	33.6-34.2	33.7-34.11
SD	1.26	0.14	0.10
within-subject CV%*	0.5	0.1	0.01

*EIMM of n=10 breaths

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Quality of spirometries to assess possible COPD in current smokers. Results from an ongoing study in general practice in Switzerland

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Routine spirometry in smokers may improve physicians[apos] awareness of COPD. So far 51 GPs performed spirometry (EasyOne, ndd, Switzerland) in consecutively recruited current smokers. All GPs were trained during a two hours course to conduct spirometry according to the ATS standards. The quality of each spirometric test was assessed (Respir Care 2000;45:513-30). FEV1, FVC and FEV1/FVC were recorded and the predictive values were based on those of the ERS and on those of Switzerland (SAPALDIA). The severity of possible airway obstruction was analysed using GOLD criteria.
We could analyze 2048 out of 2113 spirometries (97%). Of these 2113 spirometries, 702 tests (34.3%) had quality [quot]A[quot], 140 (6.8%), 369 (18%), 564 (26.7%), and 273 (13.3%) were of quality [quot]B[quot], [quot]C[quot], [quot]D[quot] and [quot]F[quot]. Based on the predictive values of the ERS and SAPALDIA, 68% and 59.7% of patients showed normal spirometries, 10.5% and 6.6% mild obstruction 10.4% and 13.3% moderate obstruction, 5.5% and 6.6% severe obstruction. Possible restriction was documented in 5.5% and 13.8%. The results remained unchanged after all tests of worst qualtiy ([quot]F[quot]) were deleted.
In this GP based study, an acceptable quality could be achieved in 59% of the spirometries. Airway obstruction was found in 25% of current smokers.
Financially supported by Boehringer Ingelheim AG Switzerland and Pfizer AG Switzerland.

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System feasibility of DLCO measurements based on ultrasonic flow and molar mass sensors

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Measurement of single breath carbon monoxide diffusing capacity (DLCO) normally requires relatively complex systems that integrate separate gas sensors for tracer gas (i.e. helium) and CO concentration measurements with a flow/volume sensor. The prototype system presented uses an electronically controlled gas delivery system, an ultrasonic flow meter, ultrasonic molar mass measurement of tracer gas concentrations and a separate sensor for CO concentration measurement. Response times (t_{10-90}) for both gas sensors are <150 ms. Accuracy and reproducibility of the system have been investigated in-vitro using a DLCO simulator (Hans-Rudolph, USA) with three different precision gas mixtures. Using two different inspiratory volumes (2.5 and 5.0 litres) six DLCO values were simulated.

Results: Overall mean difference from target DLCO was -0.2 DLCO units (n=30, sd=0.96), mean reproducibility within a group (n=5) was 0.90 DLCO units (see figure). Mean error of alveolar tracer concentration measurements using the new ultrasonic molar mass sensor was only -0.58% (sd=0.77%).

In conclusion, we have demonstrated the feasibility of a prototype system for DLCO measurement based on ultrasonic measurements of flow and molar mass combined with a separate CO sensor.