

# Accuracy of carbon monoxide diffusing capacity washout volumes

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## Abstract

Accuracy of carbon monoxide diffusing capacity washout volumes. RL Jensen, H Gallo, RO Crapo and C Buess. University of Utah and LDS Hospital, Salt Lake City, Utah and nnd, AG Zurich Switzerland.

**Introduction.** Assessment of washout volume during a DLCO test is critical to achieving accurate and reproducible DLCO values. Calculated DLCO values can be greatly altered if the DLCO washout volume is incorrect and sampled carbon monoxide and tracer gases are contaminated with test gas from the upper airways.

**Methods.** Measurements were made on five normal subjects to compare DLCO washout volume calculations from a Viasys Vmax Spectra (Viasys Inc. Yorba Linda, CA) with washout volumes measured with an ultrasonic flow sensor (nnd Zurich Switzerland) and a mass spectrometer (MGA 1100, Perkin Elmer, Pamona, CA). Subjects performed standard DLCO maneuvers on the ultrasonic flow sensor by breathing tidally, fully exhaling, fully inhaling and holding their breath for ten seconds. At the end of ten seconds they exhaled and returned to tidal breathing. Tests were repeated four times. The mass spectrometer's 216 ms lag time was used to align the CO<sub>2</sub> concentrations with the ultrasonic volume measurements. Washout volumes were visually set on the Vmax system and calculated with the nnd software from volume differences between the start of exhalation and start of phase III of the CO<sub>2</sub> gas curve where alveolar gas should be sampled.

**Results.** The reported washout volumes for the Vmax system averaged 2210 +/- 503 ml. Average washout volumes from the ultrasonic system were 467 +/- 115 ml. The average individual difference between the two methods of measuring washout volume was 1743 ml.

**Conclusions.** The reported Vmax DLCO washout volumes were significantly higher than those measured with the ultrasound mass spectrometer system. These reported washout volumes might lead to incorrect assessment of the quality of DLCO tests on Vmax systems.

## Methods

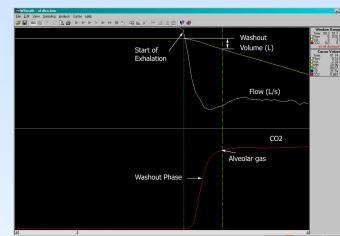
Measurements were made on five normal volunteer subjects (ages 24 to 65) to compare DLCO washout volume calculations from a Viasys Vmax Spectra (Viasys Inc. Yorba Linda, CA) with washout volumes measured with an laboratory system. The laboratory system included an ultrasonic flow sensor (nnd Zurich Switzerland) and a mass spectrometer (MGA 1100, Perkin Elmer, Pamona, CA).

Subjects performed standard DLCO maneuvers on the ultrasonic flow sensor by breathing tidally, fully exhaling, fully inhaling and holding their breath for ten seconds. At the end of ten seconds they exhaled and returned to tidal breathing. These tests were repeated four times for each subject.

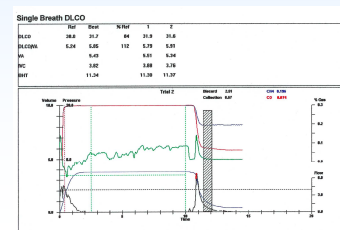
The mass spectrometer's lag time was determined to be 216 ms and was used to align the CO<sub>2</sub> concentrations with the ultrasonic flows & volumes. Each washout volume was calculated with the nnd WBreath software from volume differences between the start of exhalation and start of phase III of the mass spectrometer CO<sub>2</sub> gas concentration curve at the point where alveolar gas was present. Washout volumes were averaged for the four values.

Four DLCO tests were done with the Vmax system, washout volumes were visually set by an experienced pulmonary technician to the point just after CH<sub>4</sub> reached a stable plateau.

## Mass Spectrometer – Ultrasound system



## Viasys Vmax System



We then computed the increase in BHT that would have occurred if Viasys "discard volume" is used as opposed to our laboratory system BHT.

## Results

The reported washout volumes for the Viasys system averaged 2,210 +/- 503 ml. Average washout volumes from the mass spectrometer-ultrasonic system were 467 +/- 115 ml. The average individual difference between the two methods of measuring washout volume was 1,743 ml.

## Results

The increase in Breath-Hold-Times that were calculated from the mass spectrometer-ultrasound system at washout and the Viasys system discard volume averaged 0.80 seconds. When using DLCO equations to calculate a DLCO using each BHT a change of > 6% in DLCO is observed.

All Viasys reported discard volumes exceeded the ATS/ERS recommendations and are outside the 750 to 1000 ml standards.

## Conclusion

The reported Vmax DLCO washout volumes were significantly higher than those measured with the ultrasound mass spectrometer system.

The Viasys Breath-Hold-Times are not consistent with Viasys reported discard volumes. This may indicate miss-alignment of CO and CH<sub>4</sub> gas signals with volume signals in the Viasys system or BHTs that are not representative.

Reported washout volumes might lead to incorrect assessment of the quality of DLCO tests on Vmax systems.