AbstractID: 6995 Title: A systematic study on the sources of drift in a turbine-based spirometer using a breathing simulator

Purpose: To systemically isolate and quantify the contributions of different sources of signal drift in turbine-based spirometry.

Method and Materials: To get a repeatable response from the VMM-400 spirometer , we used a breathing simulator made of an airtight cylinder. The cylinder's piston was driven by a motor to force the air in/out of the cylinder to the spirometer. A heating blanket was used to heat the cylinder, so that the in/out air would have different temperature. The piston position, thereby the cylinder air volume, was determined using a position sensor.

Results: Our data show that even when the piston was driven sinusoidally and the heating blanket was off, the spirometer exhibits a drift per cycle of 3.4% of the maximum tidal air volume due to the differential response of its turbine blade. Reversing the direction of in/out flow simply changes the drift direction. With the heating on, the drift accumulates an additional 4% per cycle. The added drift is due to the expanded air volume from the heating. The most significant drift was observed when the piston was driven in a saw-tooth pattern, either with a fast inhale followed by a slow exhale or visa versa. The difference in the measured volume between the two breathing phases can be as large as 60% or more due to the failure of the spirometer to register the volume in the low flow-rate phase and the air needed to be spent on reversing the blade at the end of the fast-changing phase.

Conclusions: The drift due to the blade asymmetry and temperature stays the same per breathing cycle (3.4% and 4%), and can be corrected in real-time. The drift due to breathing asymmetry can vary between cycles because of patient irregular breathing; the correction would most likely be complex (i.e., non-linear).