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INTRODUCTION

- The development of the RMD Negative Pressure Ventilator (NPV) is a crucial step in the development and testing of a Novel Transbronchial Biopsy Tool (NTBT).
- The goal of the NPV is to simulate physiological conditions during ventilation.
- This will allow us to test the NTBT in an environment that resembles its anticipated use in patients (breathing state).
- The NPV can determine lung volume by integrating the flow signal over time. The flow signal is detected by a flow meter
- This part of the project focuses on validating the accuracy of the flowmeter against the gold standard by performing regression analysis

OBJECTIVE

- To validate the RMD Engineering variable orifice flow meter against the Zephyr HAF series flow meter from Honeywell, which is an industry gold standard

METHODS

- A standard test lung was used. Two Zephyr flow meters and one RMD flow meter were arranged in series at the tracheal port (Figure 1).
- Each trial (n = 17) consisted of a calibration phase and a validation phase.

Calibration Phase

$$(\text{flow} = A * (\text{pressure}^2) + B * (\text{pressure}) + C)$$

- A and C are set to 0 on the microcontroller. The test lung is ventilated and pressure data from the RMD flow meter and flow data from the Zephyr were collected.
- Regression analysis was performed to yield values for A, B, C and R², which outlines the relationship between the pressure and calculated flow for the RMD flow meter.



Figure 1. Experimental setup: two Zephyr flow meters (black) and RMD flow meter (clear) in series

Validation Phase

$$(\text{measured flow} = A * (\text{calculated flow}^2) +$$

$$B * (\text{calculated flow}) + C)$$

- The values for A, B and C obtained during the calibration phase were entered into the microcontroller.
- The test lung was ventilated, and data was collected. Regression analysis was performed.
- This yielded new values for A, B, C and R² to outline the relationship between the RMD and Zephyr flow curves.

RESULTS

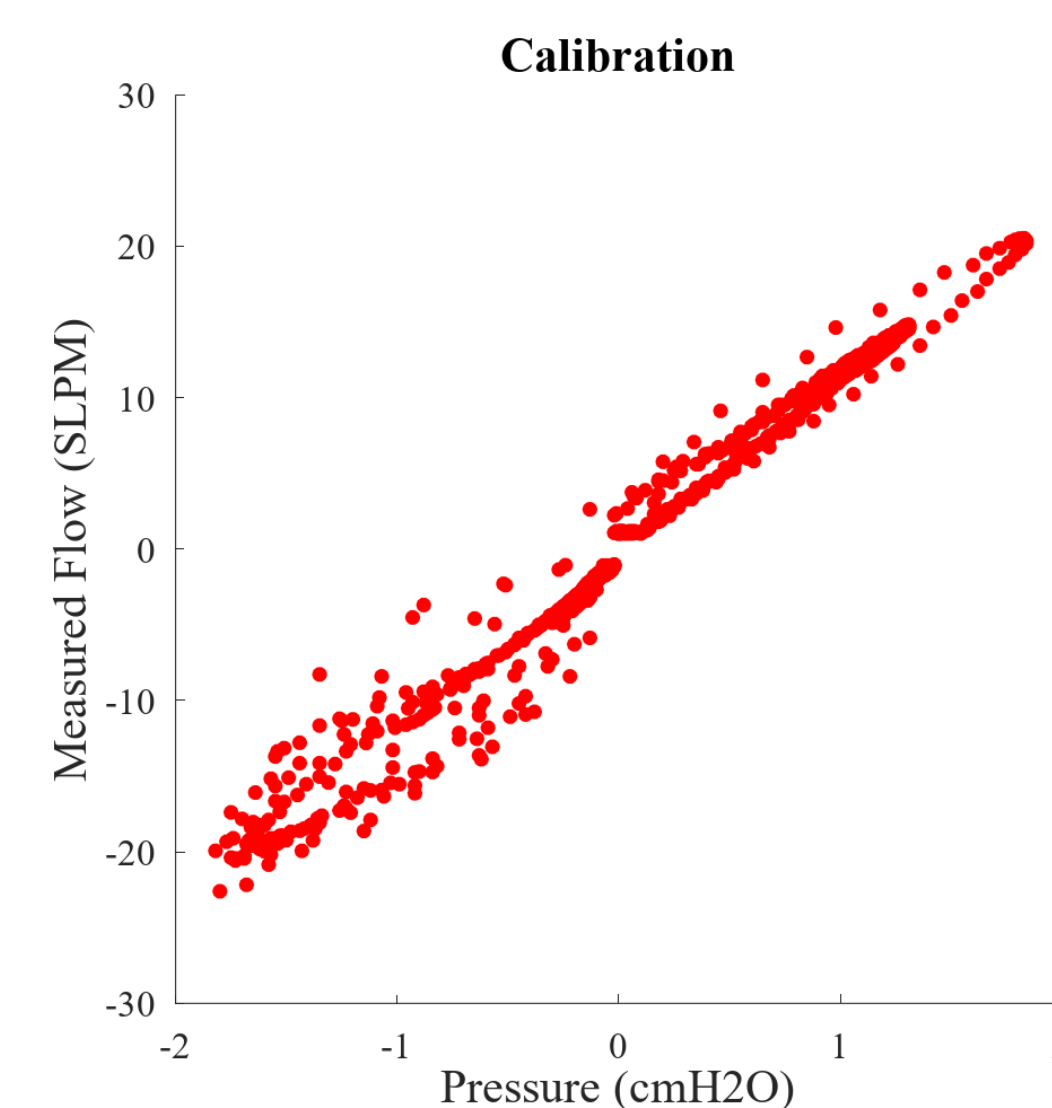


Figure 2. Raw data for the calibration phase. Measured flow represents the Zephyr flow. Pressure represents the difference in pressure observed in the RMD flow meter.

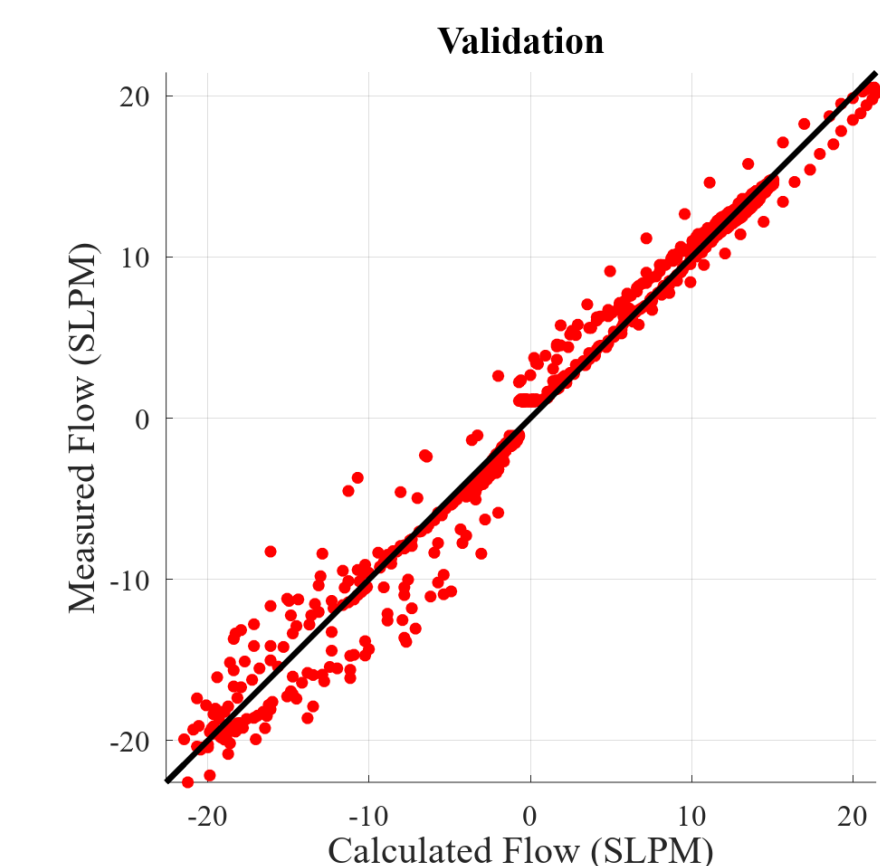


Figure 3. Scatterplot of flow (Zephyr) vs flow (RMD)

- Calibration Phase: R² = 0.98
- Validation Phase: R² = 0.91

DISCUSSION

- Since the R² values for both the calibration and validation phases were above 0.9, we can conclude the RMD flow meter accurately measured flow.
- Results of the validation showed measured flow = calculated flow (since A and C were insignificant in the final formula)

ACKNOWLEDGEMENTS

This study was funded by the University of Saskatchewan Respiratory Research Centre and the RUH Foundation Grant. The Respiratory Research Centre also provided a stipend for B. Yang.