



Background and Motivation

Chronic Obstructive Pulmonary Disorder (COPD) is a progressive lung disease that leads to airflow limitation and difficulty breathing

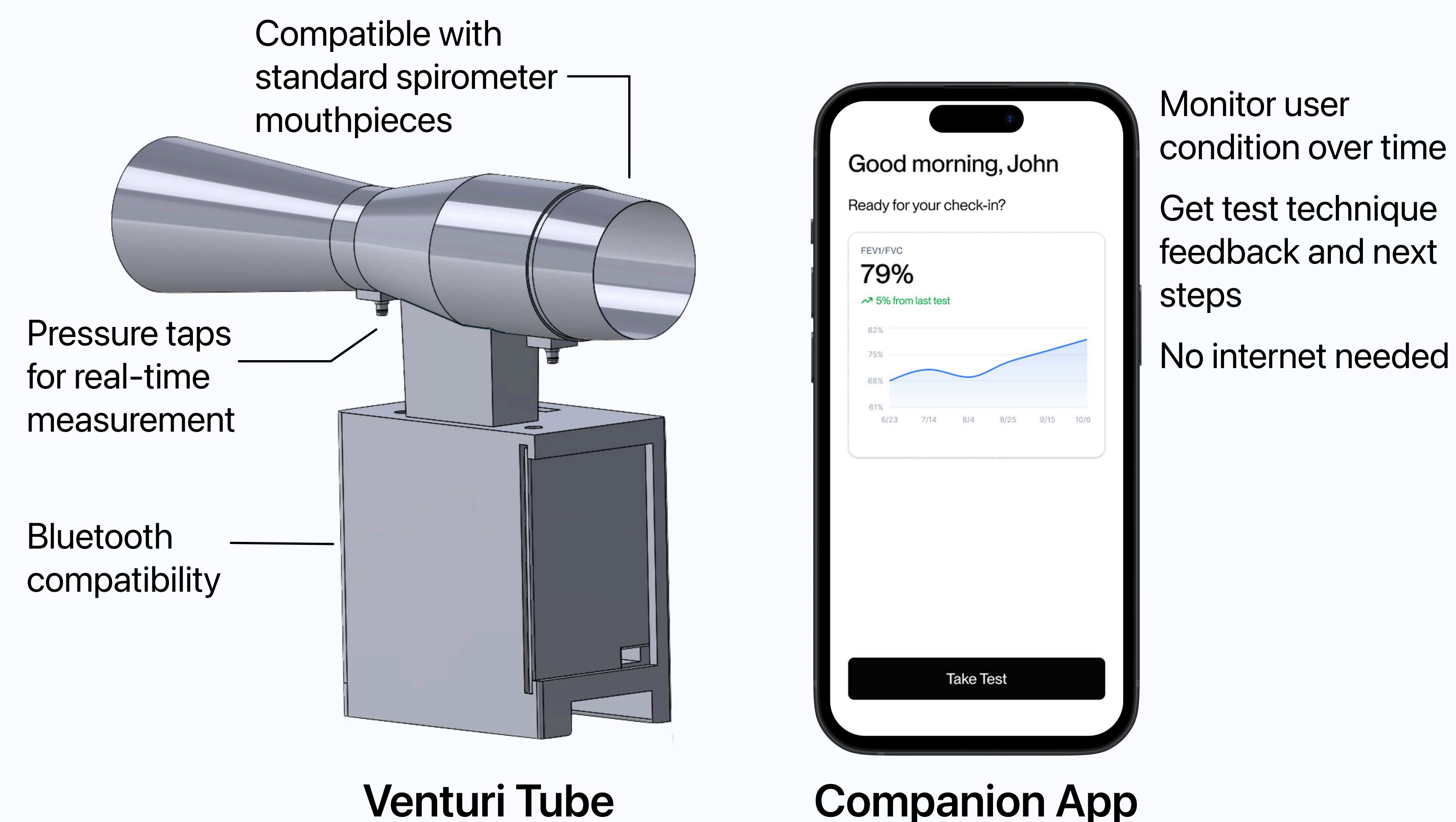
2 Million Canadians live with COPD

4+ Week Wait for clinical testing

Rural populations face double the risk of COPD, yet travel and accessibility barriers often prevent routine lung function testing (spirometry)

These barriers highlight the need for an accessible and reliable solution for monitoring lung function outside of clinical settings

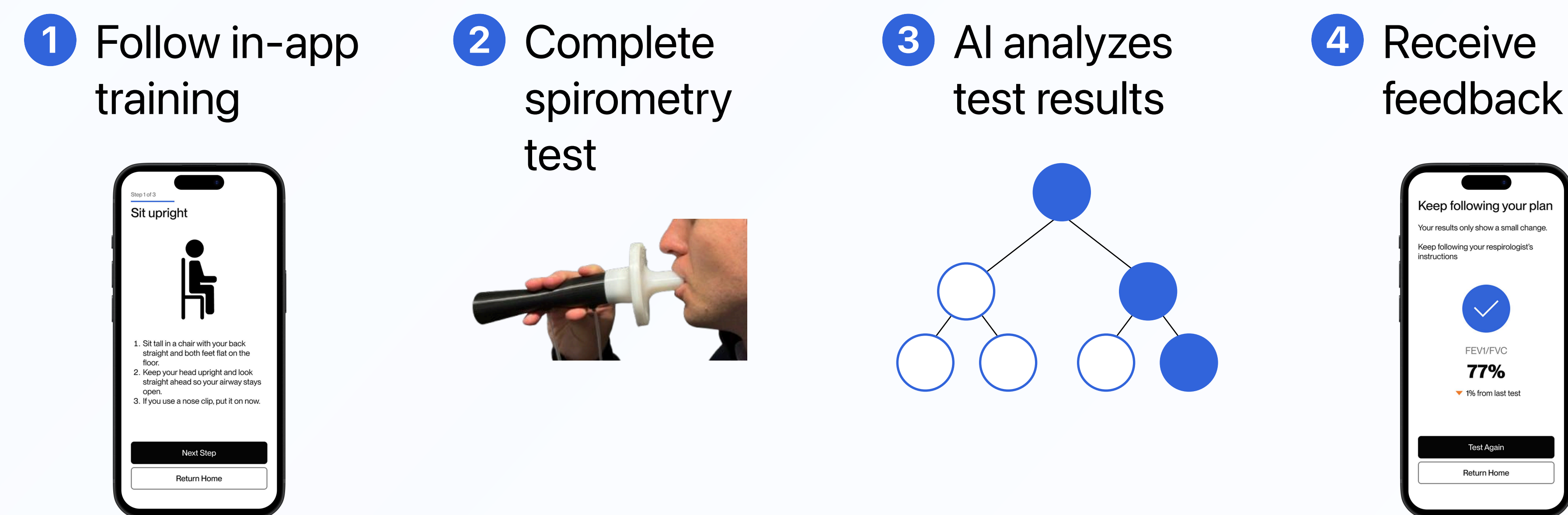
Bringing clinical-grade respiratory care home.



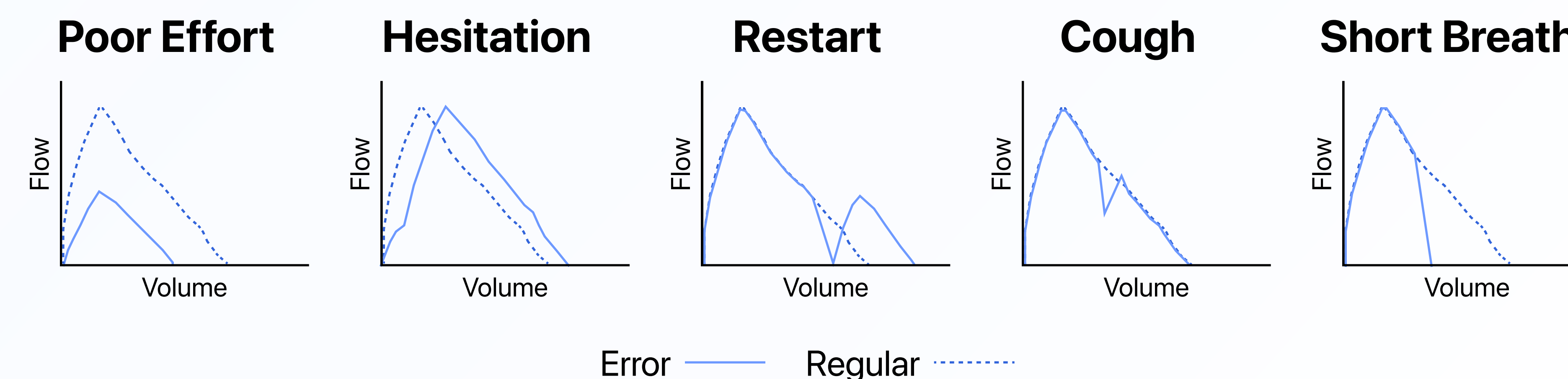
Key Metric:

$$\frac{FEV_1}{FVC} = \frac{\text{Volume exhaled in the first second (L)}}{\text{Total volume exhaled (L)}} = \text{Lung Airflow Efficiency Ratio}$$

How it works



Common Errors



Conclusions & Next Steps

90%
Regular vs Non-Regular
Test Accuracy

70%
Correct Error
Prediction Accuracy

Lack of data from COPD patients, would need to collect more representative samples

Future work will focus on improving algorithm and exploring potential pilot deployment in Waterloo region

Engineering Analysis

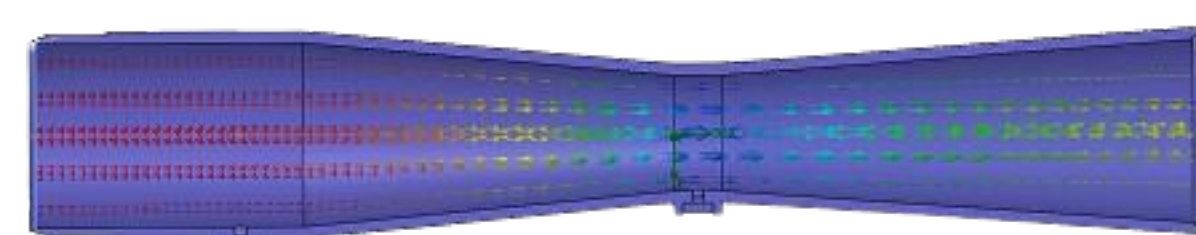
Follows requirements outlined by American Thoracic Society for spirometry and ISO 27001 for data protection



Bernoulli-based pressure to flow rate calculation

$$Q = C_d \cdot A_2 \cdot \sqrt{\frac{2(P_1 - P_2)}{\rho \cdot \left(1 - \left(\frac{A_2}{A_1}\right)^2\right)}}$$

Optimization of Venturi-based spirometer (ISO 5167)



Testing & Validation

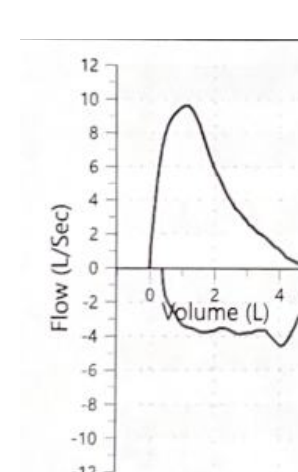
Bench calibration using a 3L calibration syringe to validate flow and volume measurements



Conducted over 400 tests to tune algorithm and improve measurement accuracy


Label	Reg	24
Non-reg	102	20
Reg	20	280
Non-reg	280	24
Prediction		


Evaluation of sensor accuracy and signal stability through comparison with clinical tests




Impact

 **Providing Clinical Quality at Lower Prices**
A low-cost design built to provide accurate testing without the premium price tag

 **Medical-Grade Compatibility**
Designed for use with standard filtered mouthpieces to maintain hygiene standards and cross-contamination safety

 **3 - GOOD HEALTH AND WELL-BEING**
3.8 - Universal Health Coverage
Enabling at-home lung function testing to improve access to respiratory care in rural areas

 **10 - REDUCED INEQUALITIES**
10.2 - Social Inclusion
Reducing geographic and mobility barriers to respiratory monitoring for underserved patients

 **4 - QUALITY EDUCATION**
4.7 - Education for Sustainable Development
Supporting patient understanding of spirometry through guided tests and error feedback

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