ACCESSIBLE AND EFFORTLESS MONITORING OF CHRONIC RESPIRATORY DISEASES IN OLDER ADULTS: A DATA DRIVEN APPROACH TO TIMELY INTERVENTIONS

SEJAL BHALLA
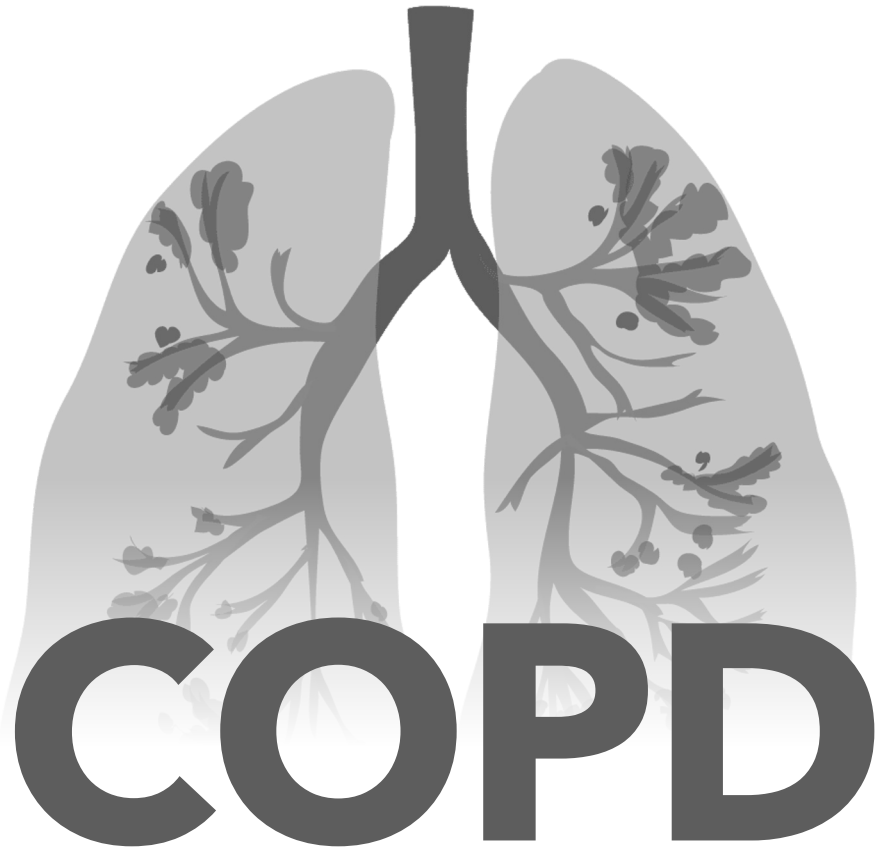
Ph.D. Computer Science, University of Toronto

CHAI | Computational Health and Interaction Lab

UNIVERSITY OF TORONTO

COPD

Chronic Obstructive Pulmonary Disease

3rd

leading cause of mortality

14%

annual deaths globally

2M

Canadians aged 35 and older living with COPD

DISEASE MANAGEMENT IS CRUCIAL!

- Chronic condition: regular respiratory monitoring and remote pulmonary rehabilitation delivery

- Acute condition: early detection of new exacerbations and ensuring adequate recovery

- Conventional approaches have included frequent lung function testing, both in the clinic and at home.
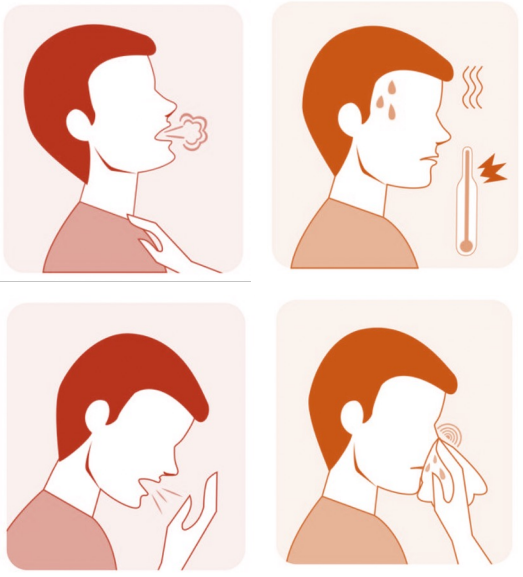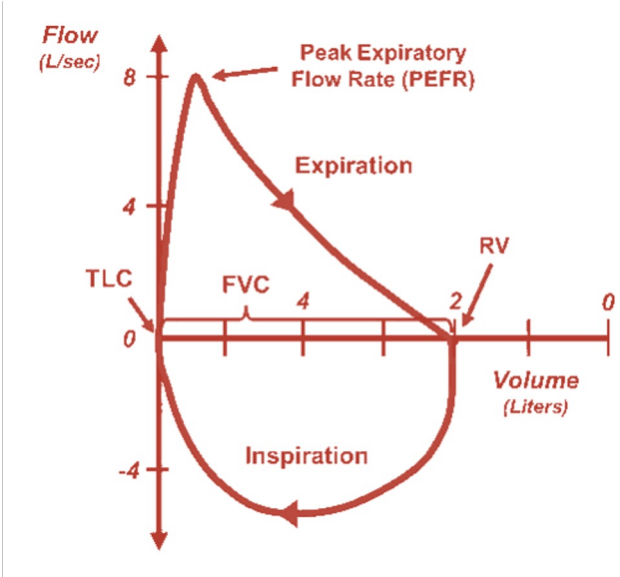
MOBILE HEALTH
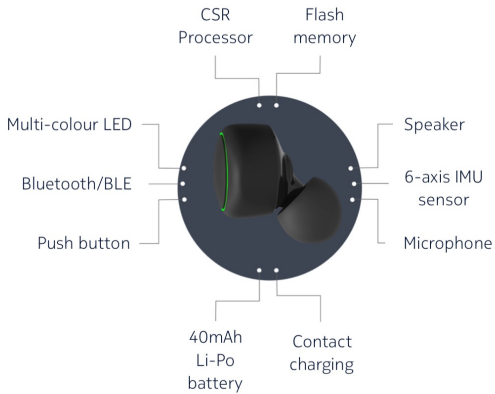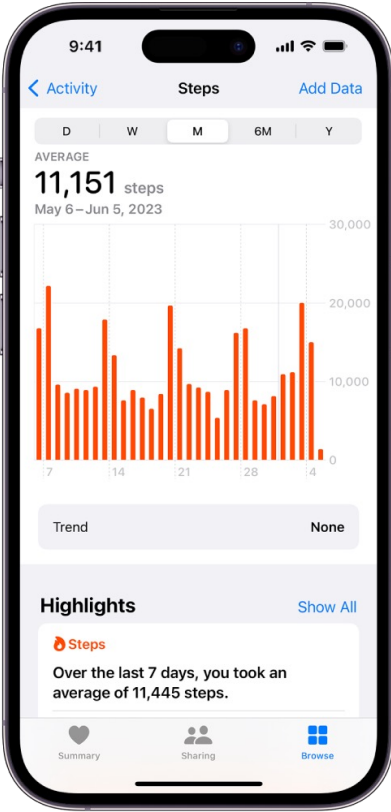
RELEVANT CLINICAL INDICATORS
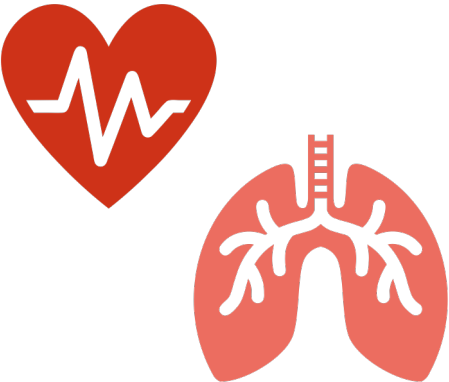
Vital Signs

Symptoms

Lung Function

A remote monitoring system should be **convenient** to use, assess respiratory health **holistically**, work in **real-world settings**, and support **continuous monitoring** and **early detection of worsening**.

IMPLICATIONS

WHAT CAN RESEARCHERS DO?

- Understand patients needs and behaviors

- Conduct studies to collect data in the wild

- Analyze and understand patterns in the data

- Evaluate efficacy and inform stakeholders

WHAT CAN POLICYMAKERS DO?

- Lay framework and guidelines for incorporating remote monitoring into clinical practice

- Enable access and education to technology for patients

PulmoListener: Continuous Acoustic Monitoring of Chronic Obstructive Pulmonary Disease in the Wild
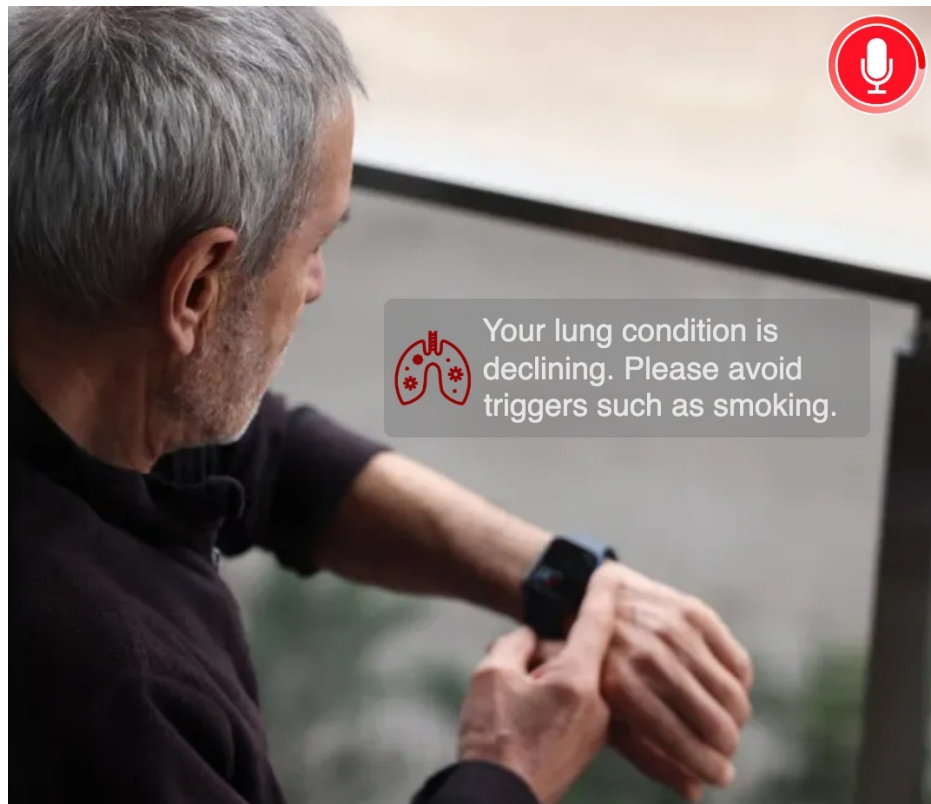
- **Data:** continuous audio collected from a smartwatch

- **Ground Truth:** Symptom severity level calculated from the daily responses on the London COPD Cohort Symptom Questionnaire [3]
  - A symptom score greater than 3 indicates high severity.

- **Duration:** 164 ± 92 days

CAN WE DETECT COPD SEVERITY?
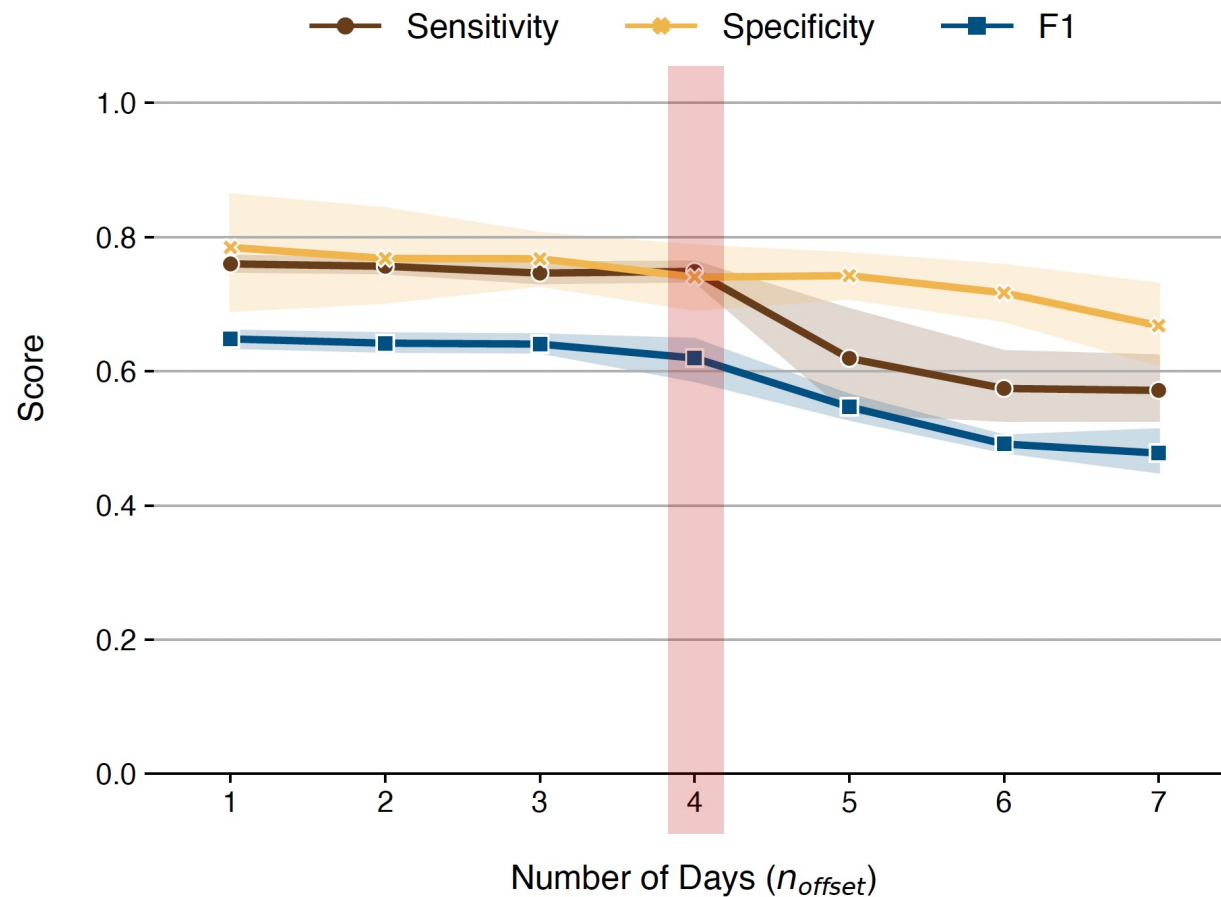
Patient
Independent
Results
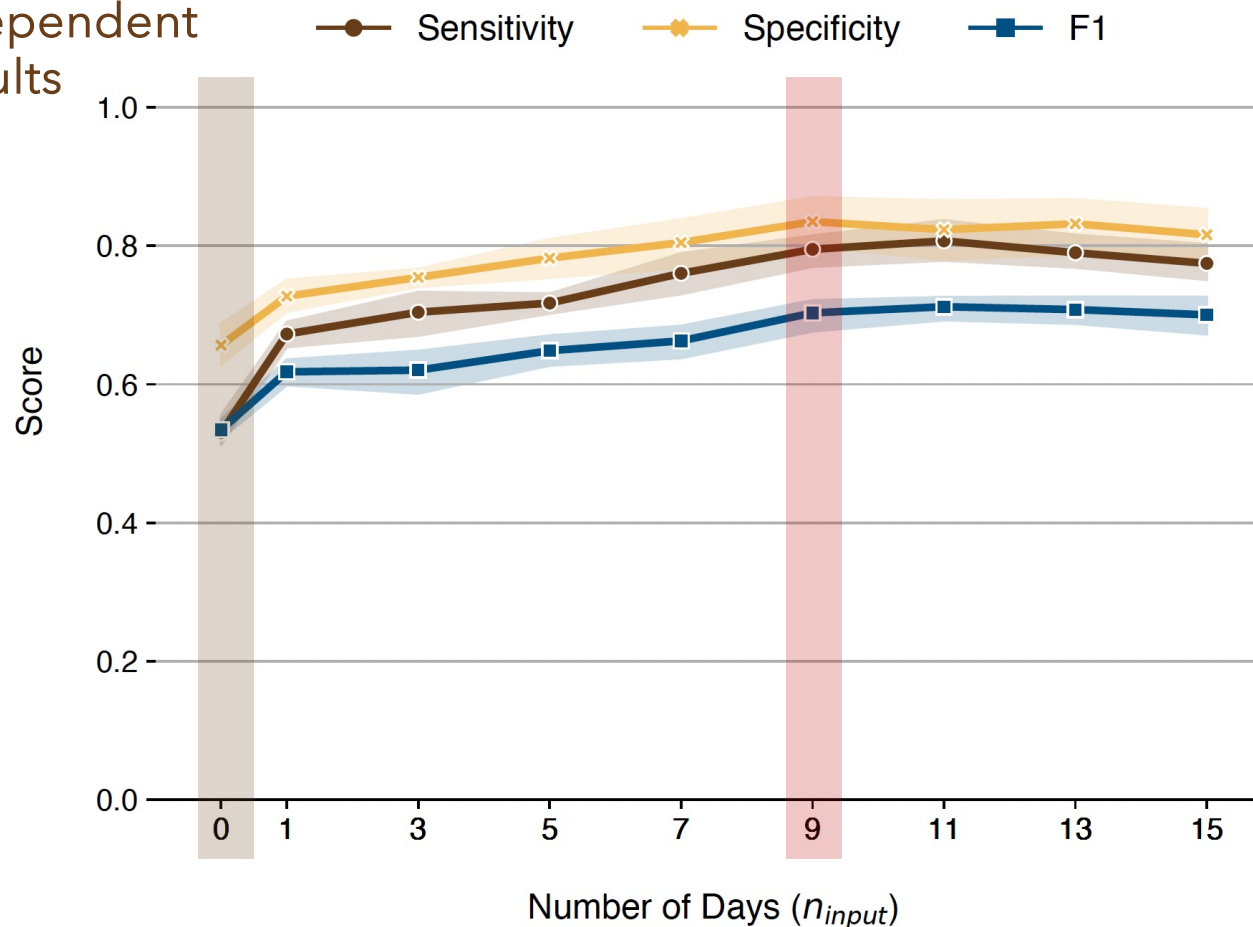
Characteristics	N = 8
Age (Mean ± SD)	66.4 ± 11.7
Women	3
Ethnicity	White (8)

Sensitivity: 0.79 ± 0.03

Specificity: 0.83 ± 0.05

F1: 0.70 ± 0.03

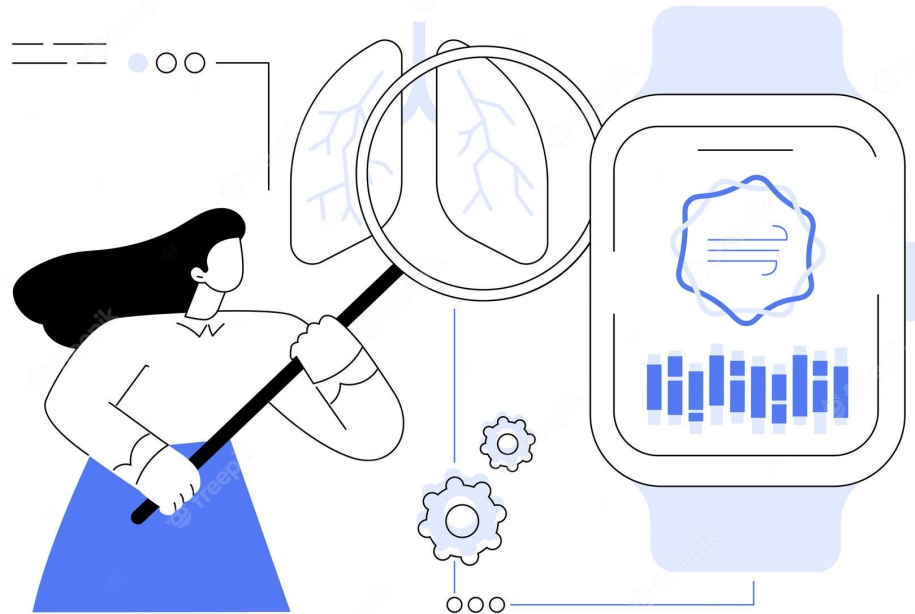# CAN WE FORECAST COPD SEVERITY?

Marginal decrease in performance up to 4 days in advance.

Sensitivity: 0.75 ± 0.02

Specificity: 0.74 ± 0.07

F1: 0.62 ± 0.03

Association Between Wearable Sensor Data And Daily Lung Condition: A Prospective Cohort Study

- **Goal:** To holistically examine the interplay of different physiological signals towards determining the present and future lung condition.

- **Dataset:** Continuous speech, activity and heart rate data collected from a smartwatch worn by 20 patients over a period of 3 months.

POTENTIAL BENEFITS TO STAKEHOLDERS
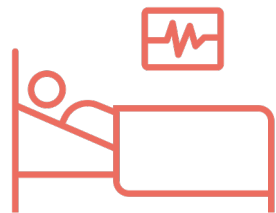
Patients

- Self-tracking and aging in place

- Actively manage symptoms by avoiding triggers

Healthcare Providers

- Timely assistance leading to lower hospitalizations

- Less burden on clinical staff

Healthcare Institutions

- Lower costs due to less hospitalizations

FUTURE WORK

Multi-modal Sensing

- Multimodal learning algorithms
- Contextualize predictions using ambient sensor data

Prospective Cohort Study v2.0

- Evaluate on new dataset and improve generalizability

Design Considerations for Monitoring Systems

- Qualitative user studies
- Optimize information load for clinicians (remote monitoring) and patients (personal tracking)

QUESTIONS?

Sejal Bhalla

sejal@cs.toronto.edu

University of Toronto

Salaar Liaqat

University of Toronto

Andrea Gershon

Sunnybrook Health Sciences Centre

Robert Wu

University Health Network

Eyal de Lara

University of Toronto

Alex Mariakakis

University of Toronto

UNIVERSITY OF TORONTO

CHAI | Computational Health and Interaction Lab

UHN

Sunnybrook