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

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Chronic Obstructive Pulmonary Disease (COPD)

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.
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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N = 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean ± SD)</td>
<td>66.4 ± 11.7</td>
</tr>
<tr>
<td>Women</td>
<td>3</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>White (8)</td>
</tr>
</tbody>
</table>

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?

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