Continuous monitoring of asthma control

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Client: Dr. Sameer Mathur

Team members: Lida Acuña Huete
               Cassandra Thomas
               Jesse Wang
**Outline**

- Problem Statement
- Client Description
- Design Constraints
- Broader Impact
- Summary of previous semester
- Specific Goals
  - Fabrication
  - Evaluation/Testing
- Documentation
- Budget
Figure 1. Asthma symptoms vs. detection time
Problem Statement

• Asthma exacerbation
  • Severe attack could be fatal
• Baseline tidal volume
  • 2 days to notice
  • Contact physician
  • Preventative measures, i.e. prednisone\(^1\)
• New technology to detect change in asthma symptoms
  • Earlier detection
Design Constraints

• Non-restrictive wires
• Allow for continuous monitoring/transfer information quickly
• Machine Washable
• Size Adjustable
Client Description - Dr. Sameer Mathur

- Affiliated with University of Wisconsin Hospitals & Clinics
- Board certified in Allergy and Immunology
- Research recruitment of adult asthma subjects

Impact

- Allow physicians access to real time data
  - Take AAP\(^2\) upon the onset of asthma attack
- Continuous monitoring
  - Reduce number of ER visits
  - Quick detection and alert (< 6 hours for treatment)
- Further testing with all ages (include children)
Previous Design and Improvements

Previous design (a) shows the front side of the shirt, with black boxes holding electrical components whereas (b) shows the placement of the microphones.
Electronic Setup

- Circuit diagram of Microphone and Resistance band connection

- Low pass filter: corner frequency $< 0.167\text{Hz}$
Electronic Housing

- Battery and circuit housing design
- Stethoscope-like housing for microphone.
Goals

- Algorithms detect peak to peak values
  - Calculate tidal volume and respiratory rate
    - Detect changes in volume of 12% or 20\%
  - Calibration to individual
- Detection of asthma attack
  - Minimize type I and type II errors
  - Incorporate volume and sound data
- Generate ‘gold standard’
Design Improvements

- Wires are detachable
- Additional sensors
- Data is collected via Bluetooth
- Microphone:
  - Cup-like shape to funnel sound
Testing
Two stages:

1. Asthma symptoms
   a. Arduino collects data
   b. Matlab analyzes
      i. Volume Δ 12% or 20% (p<0.05); isolate cough peak
   c. Create tidal volume graphs; sound data plots

2. In environment
   a. Induced asthma exacerbation
   b. Validation of device
Testing Asthma Symptoms

- Change in resistance
- Microphone sound measurement
- Tidal Volume Baseline; Wheezing and coughing

Microprocessor → MATLAB
Testing in Environment

- Has been approved, all members are IRB certified
- Can begin as soon as design is validated
- Induce asthma exacerbation
  - Similar to real life
  - Use shirt to monitor for ~1 hour
  - Under medical supervision
- Collect data to view how effective design is
Timeline

• Begin testing for asthma symptoms
  • Make sure graphs are acceptable
• Begin testing on patients currently in client’s asthma study
  • Induce asthma exacerbation
  • Record tidal volume baseline and volume Δ
  • Detect coughing and wheezing co-occurrence
• Potential for peer-review
# Timeline

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<th>Task</th>
<th>March</th>
<th>April</th>
<th>May</th>
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<td>Assemble shirt design</td>
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<td>Testing for asthma symptoms</td>
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Methacholine Challenge - C. Harty (2009)⁶

This SOP describes the responsibilities of the research team members in conducting methacholine challenges to promote adherence to all applicable federal, state, and local laws, policies, and guidelines.

Methacholine testing is performed to measure the severity of bronchial reactivity. Nearly all asthmatics with active disease exhibit narrowing of their airways when they inhale low concentrations of methacholine.
## Budget

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<th>Order Date</th>
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Budget

To be purchased: 3D-printed microphone case, PCB circuit, elastic bands

Total budget: $300.00
Acknowledgements

Dr. Sameer Mathur
Dr. Thomas Yen
Dr. John Webster
Keum Sam Chun
Elizabeth Schwantes
References


[3] K. Chun, J. Webster, I. Santos and S. Mathur, "Real-time measurement of ventilation and respiratory sound for continuous monitoring of asthma control".

