

Continuous Monitoring of Asthma Control

BME Design 301 Excellence Award Executive Summary

Tim Lieb, Luke DeZellar, Kelsey Linsmeier

Asthma is a chronic disease affecting the respiratory system. It is characterized by inflammation and increased levels of mucus, which leads to the narrowing of bronchial tubes within the lungs. This limits the amount of air that can enter the alveoli per breath to provide the body with oxygenated blood. There are four main symptoms of asthma: coughing, wheezing, chest tightness, and shortness of breath. The specific symptoms felt, and their severity, can vary widely from one individual to the next. Unfortunately, this can cause the disease to go unrecognized, underdiagnosed, and undertreated. An asthma exacerbation is an acute worsening of the disease and these symptoms. When asthma exacerbations occur, their symptoms may not be felt by the patient for a few days, causing them to worsen and making treatment more difficult.

Approximately 26 million people suffer from asthma, and that number continues to grow every year. Asthma related costs are estimated to be \$60 billion annually. The most severe asthma patients, while only 5-10% of total asthmatics, account for a disproportionate amount health-care costs, hospital admissions, doctor visits (both scheduled and unscheduled), and emergency services. Our client, Dr. Mathur from the School of Medicine and Public Health, wants to target that severe asthmatic population by creating a wearable asthma shirt that can continuously monitor asthma symptoms. Ideally, the device would be able to detect the onset of an asthma exacerbation before the patient notices symptoms, allowing for an earlier start to the patient's asthma action plan. Our team will try to detect asthma exacerbations using microphones to listen to lungs sounds, primarily coughing and wheezing.

Last semester, our team was able to create a working microphone that was able to distinguish between ambient noise, normal speaking and coughing by obtaining the signal through a data acquisition device (DAQ) and utilizing the signal processing capabilities of LabVIEW. Now, the team has focused on expanding the system to two redesigned microphones incorporated into a chest band that will be able to accurately distinguish between normal speaking, wheezing and coughing. The smaller, more ergonomic design will also be better suited for testing on real patients. To reduce bulk and weight, the redesigned microphone casings were fabricated out of acrylonitrile butadiene styrene plastic. These casings are dome shaped in order to concentrate sound to the focal point. For that reason, the microphones are placed at the center of the casing with the insulated cable threaded through a small hole in the plastic. To avoid restricting patient movement, 10 feet of the cable is provided before it is then hooked up to the DAQ.

After initially testing the device on ourselves, we will utilize an existing IRB protocol that allows the group to test the device on actual asthmatics while they undergo methacholine tests. The methacholine test will induce an asthma exacerbation in the patient which allows us to monitor the lung sounds before, during and after the attack. The results will then be analyzed to detect and isolate frequency ranges for wheezing and coughing.