301-43- Excellence- Sleep_Apnea-Executive Summary

Sleep Apnea Therapy Device

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Sleep Apnea is a sleep disorder in which natural breathing is interrupted causing frequent waking. This frequent waking caused by apnea prevents a person from reaching deep sleep leaving them tired throughout the day. It affects more than 20 million Americans and is a contributing cause of high blood pressure, weight gain, and strokes. Our design focuses on the treatment of Central Sleep Apnea (CSA), which is characterized by intermittent disruptions in the autonomic nervous system that controls breathing. The gold standard for treatment of sleep apnea is Constant Positive Air Pressure (CPAP) machines which focus primarily on obstructive sleep apnea (OSA), caused by physiological obstructions in the airway. CPAP works by increasing the air pressure on the walls of the user's airway which forces it to remain open preventing the throat from closing due to obstruction. CPAP is extremely effective in preventing OSA but falls short of being able to completely prevent CSA. This drives the need for an effective treatment for CSA.

The design centers around varying the amount of anatomical dead space of the patient. Anatomical dead space is the total volume of the conducting airways from the nose or mouth down to the level of the terminal bronchioles, and is about 150 ml on average in humans. Our final design incorporates a variable dead space container maintained by a mechanical motor to effectively treat sleep apnea. Increasing re-breathed CO_2 levels through dead space variation has been shown to reduce the occurrence of apneas and stabilize breathing. By inducing mild hypercapnia, ventilatory stimulation is increased and the symptoms of CSA may cause are alleviated.

During sleep, the user's breathing will be monitored by a flow sensor. If no breathing is detected within a fixed time interval, a microcontroller will signal the rotation of a motor which rotates a slide, uncovering slits on the breathing tube. The breathing tube is attached to a dead space capsule, providing variable airflow resistance. With decreased dead space resistance, the next breaths will increase PCO2 in the lungs, thus stimulating the brain to continue normal breathing, and preventing further apnea. This design is lightweight and ergonomically designed such that the capsule fits comfortably on the user's chest, with the wiring and power source sitting next to the user in bed.

A significant amount of testing will be conducted. At least 30 people will be asked to wear the device for 15 minutes at a time and then answer a surveying questionnaire. The main factors to be assessed from the survey are the person's ability to breath while wearing the mask, and the probability the user would be able to sleep through the night. This design provides a solution for CSA while being comfortable and autonomous.