CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Michelle Y. Zhu

Project Number

38520

Project Title

A Novel, Portable Device to Improve Brain Recovery after Traumatic Head Injury, Cardiac Arrest, etc.

Abstract

Objectives/Goals

This project aims to create a revolutionary and innovative device to induce therapeutic hypothermia, the controlled cooling of the brain to 32 deg C-34 deg C, for the prevention of irreversible brain damage after traumatic brain injury and cardiac arrest, as with current methods and devices. In detail, this project aims to cut operation cost of current devices by 100 times, size by 20 times, weight by 20 times, and increase continuous operation time by 200 times. Such innovations are important because out-of-hospital traumatic events demand portable, noninvasive and reliable solutions.

Methods/Materials

A physical pocket-sized prototype of the device uses an improved intranasal catheter to cool the nasal cavity, and in turn, the brain. The device has a closed-loop control system with sensing accessories as well as a microcontroller for autonomous control and timed monitoring of cooling elements and patient brain temperature readings in real-time. A model brain comprising of an amount of water calculated to be equivalent to a human brain, based on average human brain characteristics, was used during testing. Model temperature data were collected with a variable thermistor.

Results

The device was able to control output temperatures and maintain model brain temperatures at stable hypothermic temperatures of 34 deg C over three intervals, during which the control system maintained temperatures within ±0.1 deg C of the goal temperature. By utilizing the Peltier effect and the specialized nasal catheter, the resulting device weighs less than 1kg and costs less than $50 USD.

Conclusions/Discussion

Operation tests demonstrate the device's ability to induce and maintain hypothermia over extended operation periods. Due to its feedback control capability along with smaller size, lighter weight, higher energy efficiency, and longer operation time between recharges, this device has many advantages over current technologies.

Summary Statement

I designed, built and tested an inexpensive, portable, reliable and functioning brain-cooling device to prevent brain damage after traumatic brain injury and cardiac arrest.

Help Received

I designed, built and tested the device myself. My high school teacher Ms. Fallon provided support, supervised my experiments, and reviewed my results. Professor Newcomb (University of Maryland, College Park) provided me with advice on my control system and theory.