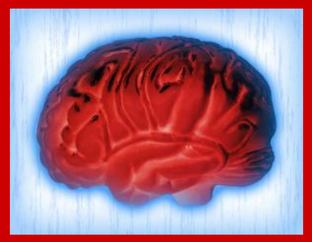

IPRO 319: Development of Solutions to Improve Survival Rate of Cardiac Arrest Patients

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Abstract

Approximately 215,000 people suffer from cardiac arrest each year, and mild therapeutic hypothermia has been shown to improve neurological outcomes. The team hoped to reduce negative outcomes in cases of cardiac arrest by producing devices that take advantage of mild hypothermia, and can be used by not only emergency personnel, but untrained people as well. Two subgroups were created to research the problem and begin development of possible solutions: jacket cooling and restricted oxygen. The team decided the best approach to solving the problem would include multiple therapies. Ultimately, the team decided to work on designing a full body cooling jacket and a restricted oxygen delivery system.

Introduction

- Most cardiac arrest victims suffer brain damage as a result of oxygen's rapid return to brain tissues.
  - The influx of oxygen rich blood to the brain can cause a series of chemical reactions that take place for up to 24 hours, causing inflammation, and ultimately leading to brain damage.
- Research has shown that hypothermia significantly reduced damage to brain tissue.
  - The reduction of brain temperatures by as few as 3 degrees Celsius improves outcomes.
- The American Heart Association recommends therapeutic hypothermia for patients who have experienced out-of-hospital cardiac arrest.

Applications

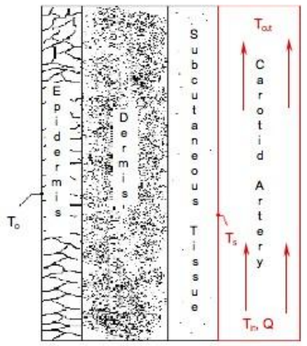
Methods for cooling the body already exist and are used in hospitals. However, there is no such method or device that can be used during the critical time period that occurs before the victim arrives at the hospital. Therefore, the targeted application for our devices is use by EMS personnel after the victim has been resuscitated. However, the restricted oxygen delivery system may hopefully be included with AED machines. EMS personnel have stated during interviews that such a device must meet the following requirements:

- Must be portable
- Must be easy to use
- Must be quick to administer/use

Design

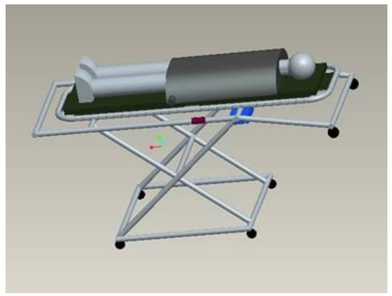
Cooling Jacket

Research was conducted to study the viability of heat transfer through the skin and tissues of the body to decide on a jacket design.



Calculations were run using accepted values for the properties of human skin and tissues in order to determine the thermal resistance.

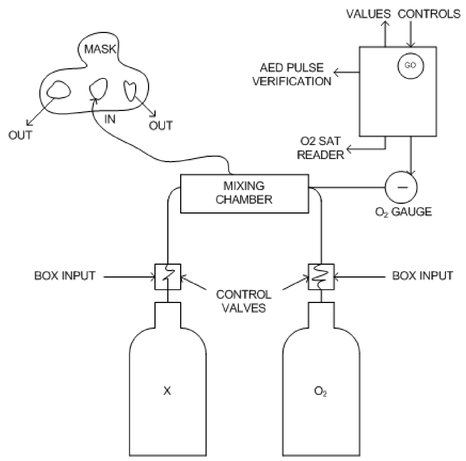
$$R_{total} = \frac{x_e}{k_e A_s} + \frac{x_d}{k_d A_s} + \frac{x_t}{k_t A_s} =$$



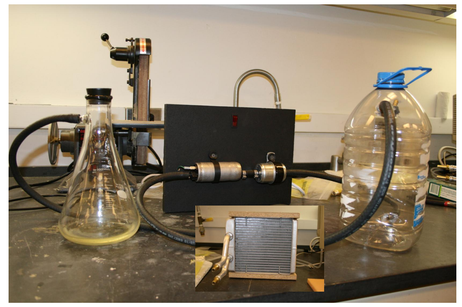
The ultimate design goal decided upon by the team would be to create a full body suit that could be incorporated into the existing stretchers used by EMS personnel.

Restricted Oxygen Delivery System

The team also hoped to begin developing a prototype that would restrict the amount of oxygen delivered to an individual. The system would have to monitor, in real time, the oxygen level of the air mixture breathed by the patient. Will hopefully prevent brain damage by reducing the sudden rush of oxygen to the brain after resuscitation.

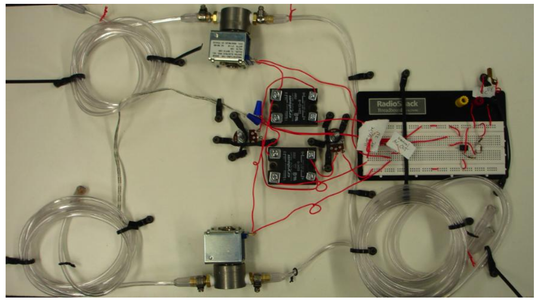


Prototype



The refrigeration cycle prototype that has been designed by the team includes a fuel pump, reservoir tank, condenser, and a flask to heat the liquid.

A simulation of human skin, which uses paraffin wax and water. A digital thermometer is used to measure the changing temperature.



A representation of the restricted oxygen delivery system circuit needed to monitor the amount of oxygen an individual breaths.

Testing

Cooling With Ice Packs

Temperature (ûC)	Time (min)
1	6.57
2	7.03
3	7.59
4	8.53

Cooling by Convection

Temperature (ûC)	Time (min)
1	4.58
2	7.53
3	12
4	17.12

Cooling With Isopentane

Temperature (ûC)	Time (min)
1	4
2	7.12
3	12.56
4	16.58

It can be seen from these results that the preliminary tests using isopentane as a refrigerant are not successful. The cooling with the ice packs was efficient dropping the temperature 0.644°C/min. Cooling by convection dropped the temperature 0.234°C/min, and cooling with isopentane dropped the temperature 0.229°C/min, which is similar to the results of the cooling by convection.

Future Work

Future work on this project will hopefully continue where the team has left off this semester and proceed with work on the prototypes. Further testing can also be carried out, and necessary modifications can be made. If these tests successfully and efficiently lower the temperature, work could possibly begin on creating a full prototype of the actual jacket, and including the oxygen delivery system in designs for AED production.