Development of Solutions to Improve Survival Rate of Cardiac Arrest Patients
The Problem

- Sudden Cardiac Arrest is a leading cause of death in the United States
- Brain injury is likely if cardiac arrest is untreated for more than 5 minutes
- Cardiac arrest results in ischemia reperfusion injury\(^1\)
  - Sudden high levels of oxygen cause brain damage
- Current procedures dictate that 100% oxygen be given to cardiac arrest victim
Mission Statement

- To minimize the damage caused by cardiac arrest through the development of devices specifically aimed at lowering mortality rate.
Goals

- Cool the brain & slow metabolism
- Reduce initial oxygen intake
- Design device for use within first 10 minutes of the cardiac arrest
- Simple, cost-effective design that minimizes potential for human error
- Design device that can be integrated into existing AED devices
Project Plan

- Study Previous Semester's work
- Research
- Create Project Plan
- Design Prototype
- Build Prototype
- Test
- IPRO DAY Prep
## Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Tank</td>
<td>2</td>
<td>$198.00</td>
</tr>
<tr>
<td>Oxygen Tube</td>
<td>7 feet</td>
<td>$24</td>
</tr>
<tr>
<td>Macroline Nylon 11 Tubing</td>
<td>5 feet</td>
<td>$5.00</td>
</tr>
<tr>
<td>High Concentration Oxygen Mask</td>
<td>2</td>
<td>$35.70</td>
</tr>
<tr>
<td>Solenoid Valves</td>
<td>2</td>
<td>$66.50</td>
</tr>
<tr>
<td>Solenoid Controllers</td>
<td>2</td>
<td>$44.68</td>
</tr>
<tr>
<td>Oxygen Sensor</td>
<td>1</td>
<td>$70.00</td>
</tr>
<tr>
<td>Thermometer</td>
<td>2</td>
<td>$35.00</td>
</tr>
<tr>
<td>Isopentane</td>
<td>1</td>
<td>$50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$443.88</strong></td>
</tr>
</tbody>
</table>
Previous Semester’s Work

- Cooling Jacket
  - Concept Prototyping
    - Basic Modeling
Research: Cooling

- Need to lower the temperature of the brain to reduce swelling after resuscitation.
- Skull is excellent insulator.
- The human body tries to maintain constant temperature.
Research: Breathing

- H$_2$S gas used in mice to induce hibernation
- Had negative results when tested on piglets
# Research: Oxygen Levels

<table>
<thead>
<tr>
<th>Percentage Oxygen</th>
<th>Effect on People</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.9%</td>
<td>Percentage of oxygen found in normal air. No effect.</td>
</tr>
<tr>
<td>19.5%</td>
<td>Minimum permissible oxygen level. No effect.</td>
</tr>
<tr>
<td><strong>15-19%</strong></td>
<td>Decreased ability to work strenuously. May impair coordination and may induce early symptoms with individuals that have coronary, pulmonary, or circulatory problems.</td>
</tr>
<tr>
<td>12-15%</td>
<td>Respiration and pulse increase; impaired coordination, perception, and judgment occurs.</td>
</tr>
<tr>
<td>10-12%</td>
<td>Respiration further increases in rate and depth; poor judgment and bluish lips occur.</td>
</tr>
<tr>
<td>8-10%</td>
<td>Mental failure, fainting, unconsciousness, an ash-colored face, blue lips, nausea, and vomiting</td>
</tr>
<tr>
<td>6-8%</td>
<td>recovery with treatment.</td>
</tr>
<tr>
<td>4-6</td>
<td>Coma in 40 seconds, convulsions, respiration ceases, Death</td>
</tr>
</tbody>
</table>
Testing

- Used layer of wax over water to simulate human body
- Tested various methods of cooling
  - Ice Packs
  - Natural Body
  - Isopentane
Solution Design: Breathing Mask
Solution Design: Cooling Jacket

- Design a device to protect the body from ischemia reperfusion injury by decreasing body temperature
- Produce a prototype of the device
Teams

Cooling
- Matti Alemayehu
- Alex Bunce
- Jessica Shaw
- Myint Toe
- Rebecca Martin

Mask building
- Gustavo Untiveros
- Caidi Zhang
- Jerry Jose
- Paul Butkovich
- Matthew Cosenza
Results

Temperature Drop Over Time

Trial 1 with Ice Pack
Trial 2 with Ice Pack
Trial 1 Natural Human
Trial 2 Natural Human
Isopentane
Obstacles: Breathing Mask

- Research on Hydrogen Sulfide has not been tested on humans to see if it will induce hibernation
  - May be done in the future on larger animals
- Human testing is not possible by the team
- Difficulty getting equipment for prototype
- EMPs are reluctant to change the way heart attack victims are treated
Obstacles: Cooling Jacket

- Humans maintain homeostasis
- Human body is well insulated
- More time is needed to do testing
- Current screen is not efficient in keeping the cooling liquid in contact with the body.

Emergency Medical Services
- Keep device simple, compact, and durable

Ethical Testing

Expense of Fluorinert
Next Steps

- Continue development of working prototypes
- Extend research into various other methods used to help patients including shaking.
- Try to study effects of Hydrogen Sulfide on humans
- Look at other chemicals that can be used to induce hibernation in humans to reduce oxygen intake and increase chances of survival
- Testing with fluorinert
Acknowledgements

- Professor Francisco Ruiz
- Professor Ray DeBoth
- Jennifer Keplinger
Questions!