IPRO 319

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

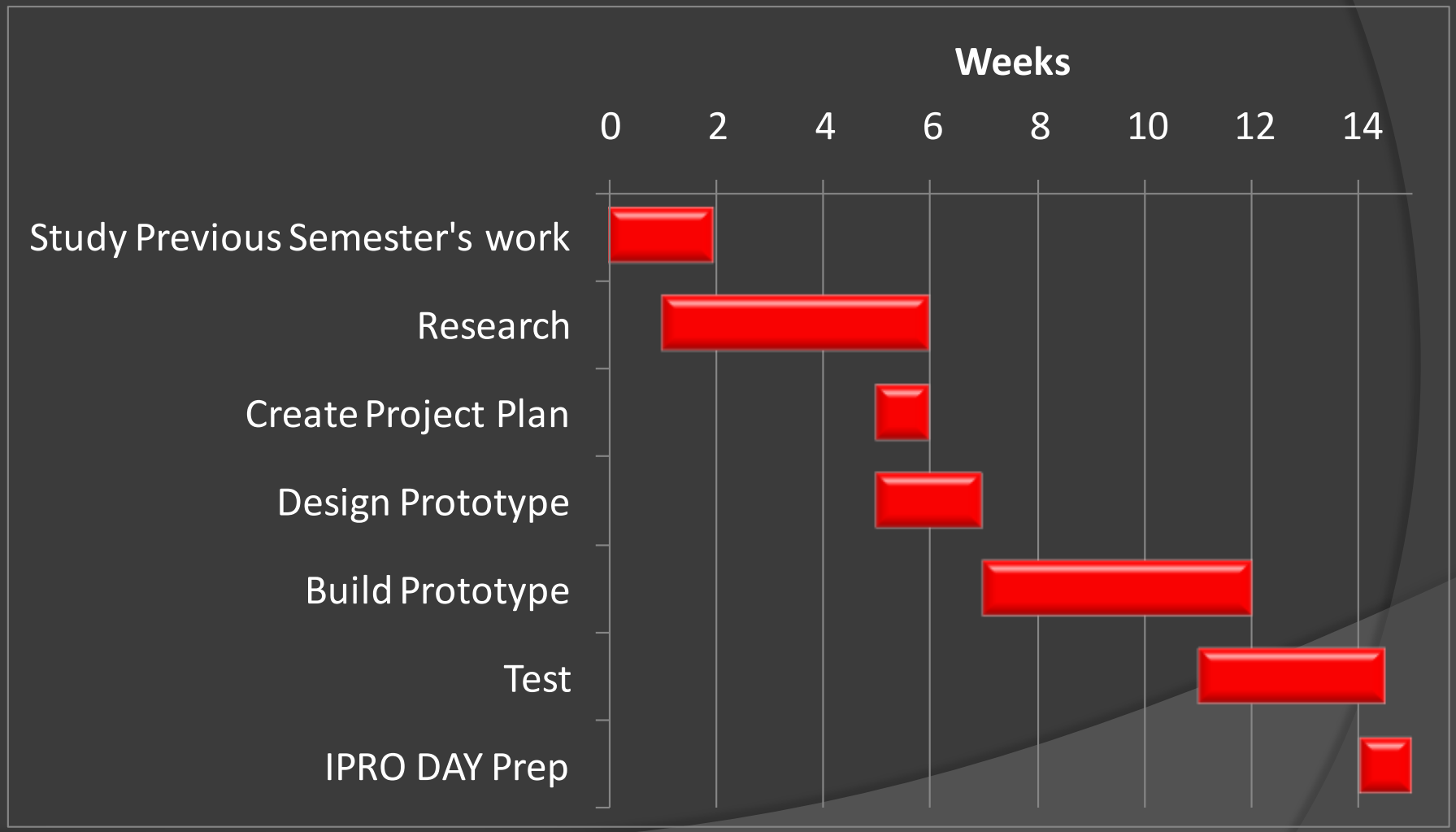
Mission Statement

- 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

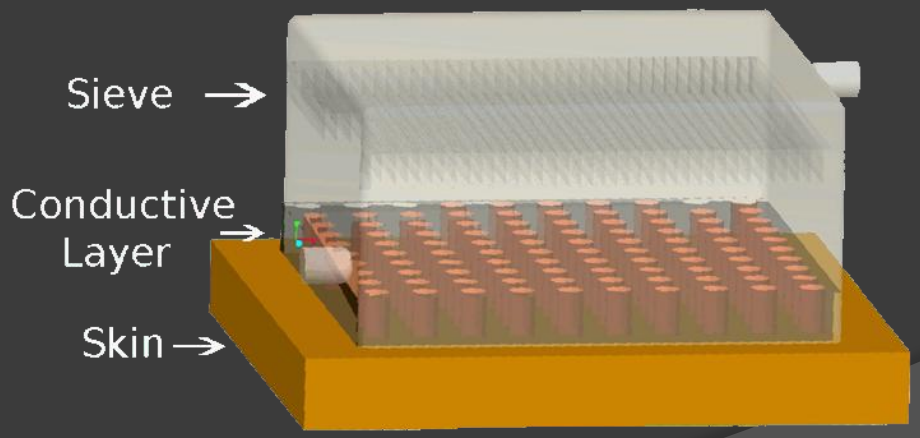


Budget

Item	Quantity	Price
Oxygen Tank	2	$198.00
Oxygen Tube	7 feet	$24
Macroline Nylon 11 Tubing	5 feet	$5.00
High Concentration Oxygen Mask	2	$35.70
Solenoid Valves	2	$66.50
Solenoid Controllers	2	$44.68
Oxygen Sensor	1	$70.00
Thermometer	2	$35.00
Isopentane	1	$50
Total		**$443.88**

Previous Semester's Work

- Cooling Jacket
  - Concept Prototyping
    - Basic Modeling

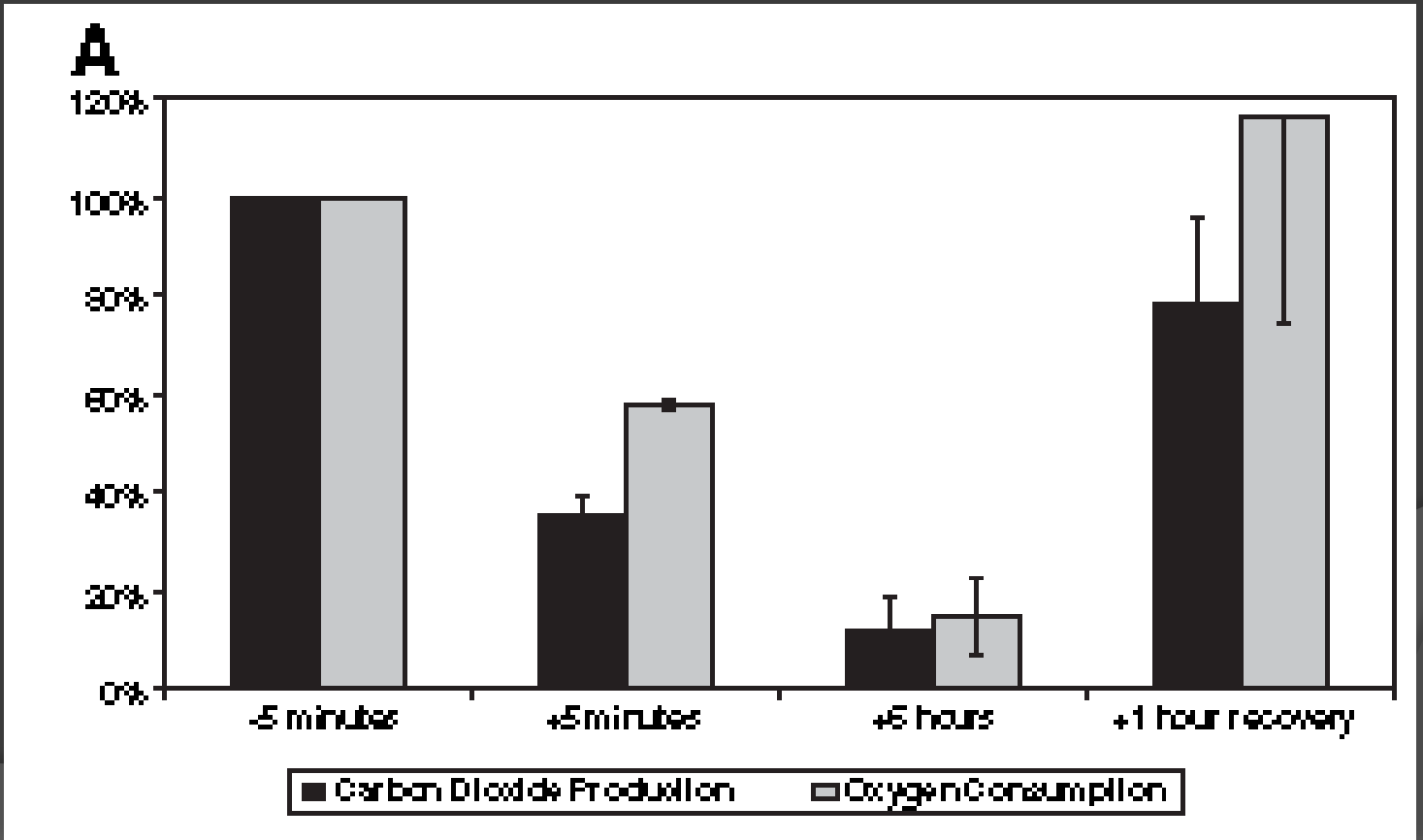


Research: Cooling

- 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_2S gas used in mice to induce hibernation
- Had negative results when tested on piglets



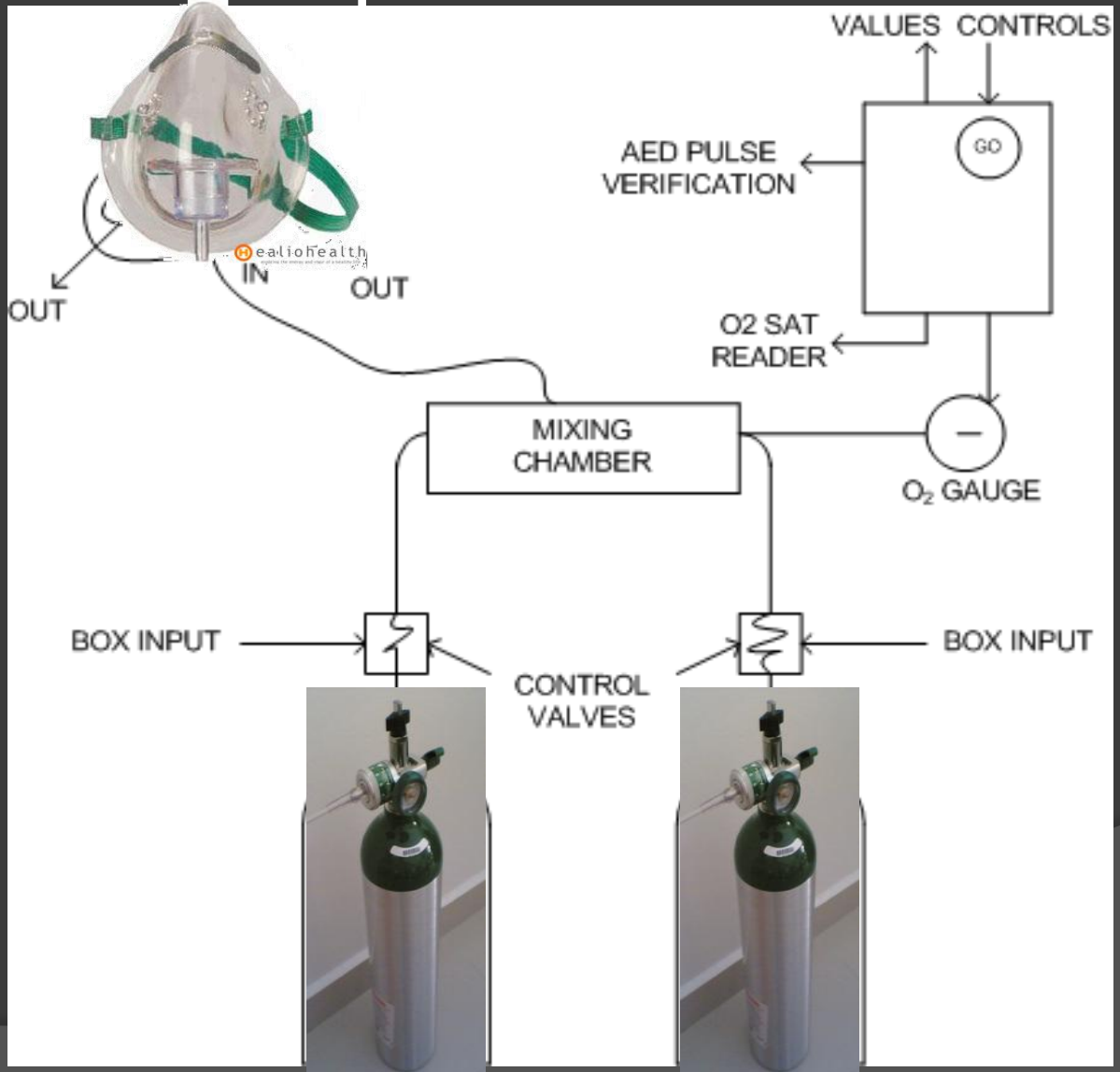
Research: Oxygen Levels

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

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

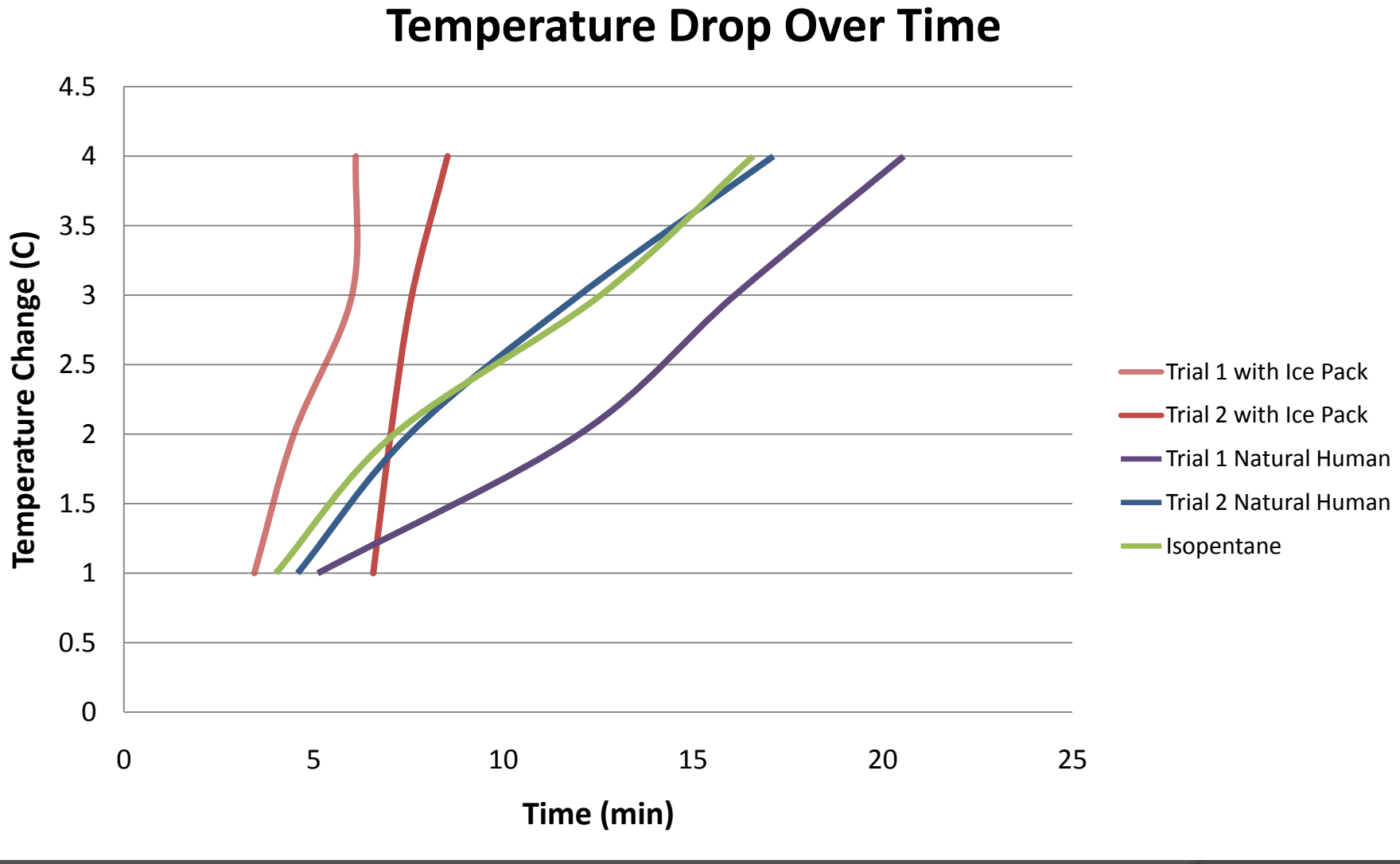
Cooling

- 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
Temperature Change (C)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Time (min)
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!