Supercomputing Challenge 2016-2017
Interim Summary

Team #1 – Team Heart – Mesa View Middle School, Farmington Municipal Schools

Caitlyn Birkby
Lucius Kvech
Brandon Tso

Background

Worldwide, 558 people have been classified as astronauts traveling in space throughout all of human history.

Astronauts are meticulous learners. They are able to conduct complex maneuvers and experiments. For instance, most have Ph.D.'s or multiple degrees and they do advanced training at Johnson Space Training for 2 years. Then, they go to the ISS program. Finally, the astronauts complete a one year training at NASA. Along the way they spend time doing vestibular visual protocols, a workshop. Russian language classes are taken so that they are effective in communicating with Russian counterparts and experts.

However, despite the fact that astronauts exercise religiously, long-term periods in space experiencing microgravity creates short and long term health problems for them. The effects of microgravity include, but are not limited to decreases in muscle mass, heart mass (atrophy), bone mass, blood pressure and compression by ribs of the lungs. Additionally, vertebral (spinal) discs increase in height and astronaut's eyes change shape 25% of the time.

There are 17.5 million people alive today. 7.4 million die of them die of heart disease per year, according to cdc.com. So, the ability to help people with heart disease, in addition to people who travel in space, makes this research more valuable.

Statement of Problem

Long term living in the microgravity environment of space leads to astronauts' hearts (cardio) becoming 9.5 more spherical (rounded). Additionally their hearts atrophy (weaken and wastes). For people on Earth and for those in space, we need to maintain and/or improve heart strength and function.

Description of Research

We have reviewed information online and scientific papers about:

1. Astronaut training and education
2. Astronaut exercise requirements
3. The effects of prolonged bed rest
4. Statistics on the number of Astronauts and general human population on the Earth
5. Gravity versus microgravity
6. Hyperbaric chamber function
7. Military applications and protocols of hyperbaric chambers
8. Basic cardiac, vascular, conditioning, deconditioning information
9. Plasma donation
10. APA citation methods

Description of Method

We did research on the internet to search out scientific articles, such as from NASA and cardiology. Then, we had to obtain permission to upload NetLogo from our school district. We spent a significant and experimenting with programming in NetLogo 5.3.1.

1. A functioning model of the heart of a "normal" Earth-bound person
2. A functioning model of a heart that has suffered from atrophy (weakening), when subjected to long-term travel in space or bed rest.

We have tried to give the agents (astronauts) objects, but need very specific data on/about incorporating:

1. Oxygen enriched environments through time in a hyperbaric chamber,
2. Oxygen enriched environments through changing the composition of the air they breathe
3. Providing plenty of vigorous exercise,
4. Providing routine plasma transfusions (from young donors)
5. Astronauts produce through respiration (breathing)
6. Can we combine hyperbaric chamber, treadmill or exercise into one machine or activity

Validating the Model

At this time we are unable to validate our model and we will not be able to due to imprecise numbers

Results

A good steady oxygen supply and vigorous exercising will slow down the atrophy process.

Conclusions/Goals

However, we hope to have found as a conclusion and as our goal is to prevent cardiorespiratory, vascular and muscular deconditioning, which will also result in the prevention of overall physical wasting and atrophy, bone mass loss, and other negative effects of space and microgravity on astronauts. This will also benefit heart patients and others here on Earth.

Significant Achievements

We have been meeting frequently and as a team. This makes our project stronger and distributes the work between members. We have learned more about each other's strengths and what we can all add to the project. We have a "person" agent that is moving

through the patch and have been able to randomize movement, have been able to program various agents physical characteristics, add buttons to auto run, reset the program we are running. We have also been able to upload coding from the NetLogo 5.3.1 manual to take a historical look at some basic game programs and be able to compare play, including lag times and how simple the games used to be. These have been fun and challenging.

We have also contacted NASA and received information from them, as mentioned previously.

Acknowledgements

Mr. Terrill Henegar, our computer teacher at Mesa View Middle school, who has kindly agreed to be available to answer programming questions in the future, as a consultant.

Ms. Diedre M. Thomas, NASA's Life Sciences Data Archive, Human Health and Performance Contract. Thank you for providing additional information and links to research and experiments involving NASA astronauts.

Thank you to all of our NASA astronauts from the past, present and future who have given or will give their all to help us make this project happen. We are grateful to both you and your families.

Screenshots

Code

We initially tried Blender, but shapes are not easily made and less interactive than we wanted. Animation was much harder than we thought it would be in Blender. NetLogo 5.3.1 actually is working the best as our agent-based model.

We are still in the process of experimenting with code and referring to NetLogo 5.3.1 Manual. We have no specific programming that we are doing beyond what we mentioned in significant achievements, so far.

References

Astronaut/Cosmonaut Statistics. (2015, September 03). Retrieved December 08, 2016, from http://www.worldspaceflight.com/bios/stats.php

Chowdhury, A. A., & Jerks, K. C. (2015, July 15). Medical Operations. Retrieved November 17, 2016, from www.lsda.jsc.nasa.org

Miller, S. G. (2016, July 28). Deep-Space Heart Health: Astronauts Face Cardiac Problems. Retrieved July 28, 2016, from http://www.livescience.com/55572-heart-disease-deep-space-radiation.html

Space Medicine And Health Care Systems Office/March 2005/ Medical Requirements integration

Katherine Ellen Foley/Jan 21,2016/How do astronauts grow plants in space?

Maki ISHIBASHI,1,* Akiyoshi HAYASHI,1 Hideo AKIYOSHI,1 and Fumihito OHASHI1/The Journal of veterinary medical science/v.77(3); 2015 Mar/The influences of hyperbaric oxygen therapy with a lower pressure and oxygen concentration than previous methods on physiological mechanisms in dogs