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Research In Progress Report

Research Question:
How does the absence of gravity affect the cardiovascular system and what does this mean for long-term space travel?

Bibliography

1. Baisch, F., et al. "Cardiovascular Response to Lower Body Negative Pressure Stimulation before, during, and After Space Flight." European Journal of Clinical Investigation 30.12 (2000): 1055-65.Print.

The study concludes that some of the changes in blood pressure during space travel can be attributed to the rapid change of fluid in the body versus a change in the cardiovascular system trying to adapt. This shows though I am focusing on the heart, there are other factors that may be affecting the system. I found this source a bit difficult to digest, as is a bit wordy and a translation, but the information is useful.

2. Clément, Gilles. "The Maintenance of Physiological Function in Humans during Spaceflight." International SportMed Journal 6.4 (2005): 185-98. Print.

This source explores the physiological effects of long and short term space travel in relation to a mission to mars. This will help me with my speculations of how our bodies changes in space affects space travel. It describes the difficulties astronauts face and what can be attributed to this and the countermeasures that can be taken, which relates well to my topic.

3. DeCampli, William M. "The Limits of Manned Space Flight." Sciences 26.5 (1986): 46. Print.

In the journal, it specifically describes what happens to cardiovascular system in space. The walls of the heart weaken in returning astronauts. This could be potentially dangerous when returning to earth, making long term travel to dangerous with current technology.

4. Evans, Joyce M., et al. "Artificial Gravity Training Helps Maintain Cardiovascular Function in Subjects Deconditioned by Bed Rest." FASEB Journal 21.6 (2007): A952-. Print.

The journal is more mathematical data heavy than the others. I did take AP stats in high school so I do understand what it is trying to portray. The study attempted shows and suggest

that bed rest on earth could help the astronauts prepare their body for lack of gravity and controlled movement, making the transition from earth to space easier on the body.

5. GUNDEL, ALEXANDER, et al. "Heart Period and Heart Period Variability during Sleep on the MIR Space Station." Journal of sleep research 8.1 (1999): 37-43. Print.

The research describes a case study of four. It shows the effects how the heart rate changes during sleep and wakefulness up in space compared to the average rates on earth. It shows there is a decrease in heart rate in microgravity, which seems minor, but heart rate is a sign of many other health factors.

6. Hargens, Alan R., and Sara Richardson. "Cardiovascular Adaptations, Fluid Shifts, and Countermeasures Related to Space Flight." Respiratory Physiology & Neurobiology 169 (2009): S30-3. Print.

This is one of the few that I have seen that take into account there may be difference in gender, when it comes to cardiovascular adaptation. I find that fascinating when it is known that men and women experience things like heart attacks differently. This is a compilation of ten years of research. It talks about how the blood vessels may become compressed and the remodeling of the cardiovascular system in space. The study mostly focused on how to reverse these effects with exercise. This ties in well with my question, as I can use this to describe the feasibility of long term travel.

7. Hargens, Alan, Roshmi Bhattacharya, and Suzanne Schneider. "Space Physiology VI: Exercise, Artificial Gravity, and Countermeasure Development for Prolonged Space Flight." European Journal of Applied Physiology 113.9 (2013): 2183-92. Print.

By the same researcher as the source above, this journal discusses how exercise is not enough of a countermeasure against cardiovascular weakening in space. It brings up the suggestion of creating artificial gravity for astronauts, because some of the most effective exercises are simply not as effective in space without some form of gravity. Though I wonder how can gravity be stimulated.

8. Horton, Richard. "Research Takes Off into Space." Lancet 342.8879 (1993): 1106. Print.

This describes heart and muscle atrophy, among other physical changes in the body while in space. Though this is useful information, this source is not as specific as the others and it may be a bit outdated compared to the others.

9. HUI, Z. H. U., HANQING WANG, and L. I. U. ZHIQIANG. "Effects of Real and Simulated Weightlessness on the Cardiac and Peripheral Vascular Functions of Humans: A Review." International Journal of Occupational Medicine & Environmental Health 28.5 (2015): 793-802. Print.

The source explains the drastic effects that occur to the cardiovascular system without gravity. It states the heart changes shape and mass in space. Also, it explains the changes in heart rhythm and how lack of gravity affects blood distribution.It mentions the effects of long term space travel. This source is a jackpot that neatly helps answer my research question.

10. Keith Sharp, M., Jerry Batzel, and Jean-Pierre Montani. "Space Physiology IV: Mathematical Modeling of the Cardiovascular System in Space Exploration." European journal of applied physiology 113.8 (2013): 1919-37. Print.

This is another source that uses mathematical modeling to understand what happens to the cardiovascular system in space. This data is useful because it provides what we can not ethically perform on human test subjects. The modeling goes over what could happen in long term travel, key to part of my question, and provides information to what could happen to to different areas of the heart system, key to the other half of my question.

11. Verheyden, Bart, et al. "Adaptation of Heart Rate and Blood Pressure to Short and Long Duration Space Missions." Respiratory Physiology & Neurobiology 169 (2009): S13-6. Print.

This study reviews eleven different males who have participated in nine different travels to space. It analyzes their blood pressure before and after long space travel. There was a decrease in pressure over time and suggests that the system becomes relax over six months, meaning it works much less efficiently over time in space. Being less efficient is dangerous.

12. Hughson, Richard L. "Recent Findings In Cardiovascular Physiology With Space Travel." *Respiratory Physiology & Neurobiology* 169.(2009): S38-S41. *Academic Search Complete*. Web

This source merely reinforces other similar sources. The heart physically changes in space, causing a decrease in function. This could be stopped with regular reinforcive counter measures.

Credibility

All my sources are from well established journals and well established institutions who have been dealing with space travel and its effects for several years, or decades. Some of the names attached to a journal or study pop up in more than one source because they are researchers with long standing in their fields.

What is still missing:

I have a fairly good collection of sources from various journals and institutions. I can securely say that I can answer my research question with the information I have collected. Though I still believe I need a source that explains how the heart functions regularly on earth. It may seem like common knowledge, but from my experience, many do not know their own cardiovascular system. So in turn, I want to start my paper with a basic intro to how the heart works, that way my paper will be understandable to someone with little knowledge of science. I am also coming to the conclusion I may have to define terms like microgravity before I use them, so those not so versed in space understand I am just using the official term for low gravity.

Because of my research, I want to look into the possibility of artificial gravity being a counter measure for cardiovascular atrophy. It is not currently possible, but it could be. I also want to look into how we are evolutionarily adapted for earth because it would had to my paper's intro.

Relevance to topic:

I made sure each source had information that I could potentially use. I did not want to waste time finding multiple sources but only being able to use a small handful. Several of the sources conform similar themes, that the cardiovascular system does not do well in space. But each source is unique as each one focuses on something slightly different, such as heart rate, long term effects, feasibility of long term travel or the blood pressure.

A common recurring theme I have noticed is some of my sources are the result of case studies. This is to be expected because there are not many ways to ethically conduct physical research on this topic, so it is more simple and effective to analyze the astronauts themselves while they are on earth and in space. Though case studies can be very useful, there is a reason I included sources that contained mathematical findings. It is possible after multiple space visits the effects of microgravity are more pronounced in astronauts, potentially skewing results. I want to be able to fully defend the accuracy of my paper.