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PREDICTION AND ASSESSMENT OF CORONARY ARTERY DISEASE RISK IN ASTRONAUTS

Abstract

In 2013, NASA's Integrated Cardiovascular experiment at the ISS studied the changes in mass, shape and form of astronauts' hearts in zero-gravity. It proved that human heart becomes more spherical and loses muscle mass in space due to reduced heart activity. This was corroborated by another study in 2016, which researched long-term health of Apollo astronauts and found that deep-space astronauts are five times more likely to succumb to heart diseases due to radiations in space.

Current methods for diagnosing Coronary Artery Disease (CAD) include minimally invasive methods such as: functional imaging of coronary arteries using computed tomography, cardiac positron emission tomography and cardiac magnetic resonance imaging to assess alterations in myocardial and coronary blood flow; stress echocardiography to measure strength and timing of electrical signals as blood flows through the coronary vessels and different parts of the heart; and, electrocardiogram (EKG) to record strength of electric signals as they pass through coronary arteries. Invasive diagnosis methods include: blood tests and measurement of blood count parameters to monitor the change in inflammatory markers over time; and, coronary angiography to find blockages in the coronary arteries.

Amongst these, two techniques of particular relevance for prediction of CAD in astronauts are EKG readouts and quantitative measurements from the different imaging modalities. EKG measurements are significant as continuous measurements can be easily obtained by having an EKG measuring device strapped onto astronauts at all times. Results from different functional imaging methods can be reconstructed into three dimensional images to predict coronary vessel structure and perfusion within the vessel wall. Furthermore, advancement in high throughput genomics has facilitated the identification of variants susceptible to CAD, thereby improving CAD risk prediction. This can be applied towards the genetic assessment of blood count parameters for identification of CAD promoting inflammatory mediators and biomarkers during space travel.

We propose that by integrating the information obtained from the methods described above, along with artificial intelligence (AI) techniques, new methods and systems can be developed to continuously monitor the heart condition of astronauts.

With an increased use of wearable devices, monitoring the heart condition is not very difficult today. However, there are major differences between the physiology of humans on Earth and astronauts in space, as astronauts react differently when subjected to zero-gravity and space radiations. We propose AI techniques, including machine learning methods, and architecture of sensors to enable predictive and contextual analysis of astronauts' heart conditions.