Study shows headdown bedrest precisely mimics human physiology in spaceflight

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With President Bush talking up trips to the moon and Mars, and a new satellite circling the red planet, ever wonder what it feels like in space? The expensive way to find out is to hitch a ride on a parabolic aircraft trip, where you may get up to 90 "weightless" sessions of about 20 seconds each.

But if you want to find out how space flight actually affects the body, just lie down and recline your head at a 6-degree angle below your feet for a few days.

A study in the March issue of the *Journal of Applied Physiology* shows for the first time that a person at "reclining bedrest" reacts almost exactly the way an astronaut's body adapts to space.

According to lead author Todd Trappe: "Over 17 days in space, like in bedrest, we found that our ability to work or exercise began to fall almost immediately. It reached a low point at 13 days because the cardiorespiratory "engine" lost the ability to provide the body with oxygen it needs."

"This has important implications for aiding earthbound elderly, bedridden, and other individuals subjected to periods of inactivity, and also for helping to ensure the ability of our space travelers to operate as far out as Mars," Trappe added.

Soviet-U.S. interaction set 6-degree standard, but Trappe et al. showed it works

Since the early space flights in the 1960s, researchers in the U.S. and Soviet Union knew they needed an earth-bound way to study the physiology of space flight (SF). Early experiments used "chair rest," since space explorers were strapped in a chair.

"But once men started coming back from space it was obvious the cardiovascular system was significantly impacted by the microgravity environment, and physiologists realized they needed a way to model this in the gravitational environment on Earth," explained Todd Trappe, lead author of the article in the March issue of JAP.

Trappe and his colleagues performed "side-by-side" studies comparing cardiorespiratory responses to exercise and work by four astronauts on the 17-day STS-78 (Life and Microgravity Spacelab Mission) and eight earthbound bedrest subjects who mimicked the astronauts' schedules and most of their activities.

The so-called "head-down minus 6 degree bedrest" paradigm resulted from early interactions between the Soviet and U.S. researchers and doctors that considered a large range of angles that would mimic the cardiovascular effects of microgravity experienced by humans in space. However, "until our parallel studies on the STS-78 and at bedrest (BR), it was never specifically tested," Trappe noted.

A "main finding from this study highlights the adequacy of (minus 6-degree) BR as an analog for space flight," the paper stated. Furthermore, the findings showed that "minus-6-degree BR is an appropriate simulation of in-flight and postflight physiological responses to exercise. This is evidenced by the fact that the direction, magnitude, and time course of the changes in the cardiorespiratory responses to exercise were similar between BR and SF."

Parallel swift, steep declines in SF and BR indicate validity of mutual applications

Specifically, the paper reported: "Exposure to and recovery from SF and BR induced similar cardiorespiratory responses to exercise (either) on a semi-recumbent (SF) or supine (BR) cycle ergometer during submaximal and maximal exercise." Not only did the experiments find "that maximal exercise capacity is compromised during and following SF exposure," but the paper reported that the "time course of changes in cardiorespiratory responses was consistent between SF and BR."

For instance, the decline in cardiorespiratory responses on day 13 was biggest for both SF and BR in three parameters:

-- oxygen consumption maximal exercise: SF minus 11% and bedrest minus 9%,
-- change in oxygen pulse maximal exercise: SF minus 18%, BR minus 12%
-- change in oxygen pulse submaximal exercise SF minus 11%, BR minus 12%

The recovery of main variables that describe the cardiorespiratory system were also very similar between the SF and BR, suggesting that programs designed from BR to help astronauts once they arrive at the moon or Mars should be effective.

Demonstration of body's quick physiological response to environmental change

"In a way, the general changes that the body undergoes is somewhat simplistic," Trappe said. "Your body literally changes its physiology to what is demanded of it, and in microgravity and during bedrest, if you are not exercising there is not much physical demand placed on the body due to the lack of gravity. Our study adds to the relatively small pool of space-based physiological data from earlier studies that have shown how quickly the muscles, bones, and cardiorespiratory system change when they are not needed or used."

Next steps

According to Trappe, the import of the study isn't just that the SF-BR paradigm is valid, but it holds out the hope that health-care approaches based on SF and BR could be translated into the other arena. He gave several examples:

-- "Need to determine the minimum amount of exercise necessary to maintain astronauts' bone and muscle mass, as well as the cardiorespiratory capacity to support the physical work that will be required of astronauts when they travel to the moon or Mars.

-- "Once the level above is determined, it could have important implications to amount of exercise that elderly or bedridden persons might need to get or remain healthy.

-- "Based on what we learn from the three- to six-month stays on the International Space Station, we might be able to adapt physical, drug or other types of therapies to help people recover from medical conditions that require inactivity or immobility," Trappe said.

Source: American Physiological Society