

The case of the fainting astronaut

It may sound like a penny-dreadful but the case of the fainting astronaut is all seriousness. What is being learned in a fascinating International Space Station-based research project about deconditioning of the autonomic nervous system could help future space travellers and other earthlings, as Kate McDonald reports.

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has fast become an internet favourite, for all of the wrong reasons. A captain in the US Navy, a mechanical engineer and twice a mission specialist on space shuttles, she is unfortunately best known for losing a tool bag while on a space walk – or extra-vehicular activity, in space-speak – which apparently can still be spotted from Earth. And before that little boo-boo, she was captured by the cameras fainting twice at a news conference following re-entry from her first mission.

While video netheads may spoof her, which they have done mercilessly, there is actually a serious side to the fainting spells she experienced. It is in no way unusual for astronauts to faint in the hours after landing, with conservative estimates suggesting that up to 40 per cent of all astronauts will experience fainting or at least dizzy spells on their return home.

To investigate the reasons behind this phenomenon, and to find out how to avoid it in future, a fascinating research project is underway on the International Space Station. Called the Cardiovascular and Cerebrovascular Control on Return from ISS experiment (CCISS), this Canadian-led project aims to study the effects of long-duration spaceflight on the heart function and blood pressure of space crew.

There are plenty of earthly reasons for the project as well. The Canadian contingent consists of principal investigator Richard Hughson from the University of Waterloo and co-investigators Andrew Blaber from Simon Fraser University in Vancouver and Kevin Shoemaker from the University of Western Ontario. These researchers are all exercise physiologists, also known as work physiologists, with an interest in the control of blood pressure and blood flow.

They are investigating the autonomic nervous system, the system that controls temperature, digestion, heart rate and blood pressure amongst others, and which does so automatically through a variety of different reflexes.

In space, where things are a little different, those reflexes are upset – or deconditioned – by the lack of gravity. What the researchers hope



to do is understand more about the normal state of blood pressure by testing it in unusual circumstances.

“The point of all this is that in order to maintain blood pressure you have reflexes that sense blood pressure, and these are very sensitive to gravity,” Kevin Shoemaker says. “Just like training an athlete or training a muscle, these nervous systems can be trained and they can be de-trained, in simple terms. When you take away gravity you cause a significant deconditioning stimulus for this nervous system.”

When the system is deconditioned, and then returned to gravity, all of a sudden that gravity is sucking blood away for the heart, he says. “The system has changed and the net result, the most common thing that you might see – and you can see it on Youtube – is astronauts fainting.”

Fainting or dizziness is the primary symptom of deconditioning, and no one is entirely sure what causes it, Shoemaker says. It could be due to the brain, the nervous system, the

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heart itself or the blood vessels. Either way, something has changed.

“If this were to occur long-term, we don’t know what kind of problems could develop. What we are able to do with the space station is study this system over 60 to 90 days, which is the longest time ever that people have had the opportunity to study the deconditioning of space travel.”

Flight experiments

The Canadian team has been working on this project since about 1999, but for one reason or another was unable to begin in earnest until 2007. It is a long-term project, expected to last for several more years, involving at least six astronauts who are on long-term missions. The experiment protocol has three levels: pre-flight, in-flight and post-flight.

The pre-flight testing is the easiest as there is a wide window of time, Shoemaker says. A month before the mission takes off, the research team heads to Houston to collect data on the astronaut. Data is also collected immediately on their return, within the first hour or two before they stand up. “We get in there and collect their data again, and we also have them collecting some data up there at the station,” he says.

This data includes blood pressure, heart rate, brachial artery and aortic blood flows, cerebrovascular response, arm vein pressure, breathing rate and carbon dioxide expired, and baroreflex stability, or blood flow regulation.

The astronauts are also subjected to lower-body negative pressure both pre- and post-flight, in which suction is applied to the lower body in a negative pressure tank to simulate gravity, and from that the researchers are studying how much basal constriction occurs and how fast.

“The rate of change is one of the primary objectives,” Shoemaker says. “And also in the brain – how well blood vessels dilate, especially when you stand up. If this blood flow into the brain falls, then you will faint.”

The research team is eagerly awaiting its fifth subject, experienced flight engineer Sandy Magnus. The 44-year-old is on her second mission in space and is part of the Expedition 18 crew, due back in February. The reason the researchers want to get their hands on her data is simple – she’s female.

“In terms of blood pressure control, men and women typically have very similar blood

pressures, but the way that women get there is much different from men,” Shoemaker says. “A lot of our research is studying the role of oestrogen in blood pressure reconditioning. It’s really quite a potent effect. One of the interesting things with space travel is that women are much more susceptible to this problem of fainting than men are, so studying a few women is very valuable to us, because we do expect dramatic differences between the sexes.”

Faint of heart

Running the experiments is no easy thing, as the researchers have to work within the time schedule set by NASA. The pressure has been eased somewhat by an Australian connection – one of the pieces of equipment being used is the PowerLab, from Australian company ADInstruments. PowerLab is a data acquisition system that records physiological signals for easy analysis on a normal PC or Mac. It is being used to co-ordinate the collection and analysis of the variables related to baroreflex stability.

Shoemaker is happy to give ADInstruments a plug as he’s not on a retainer, and the company donated some of the equipment for the project’s second lab. The main laboratory is at the Kennedy Space Centre in Florida, where NASA prefers its space shuttles to land. If the weather over Florida is a bit dodgy, the alternative is Edwards Air Force Base in California, where the project has a second, equally well-equipped lab just in case.

“We have to get to the astronaut as quickly as possible, and it’s just way too expensive to not have a team at both (bases), so we send four people and a whole lab down to California every time the shuttle lands,” Shoemaker says.

“To help us get going they donated some equipment to us to use and shipped us a couple of pieces of brand new equipment to make sure we collected the data, should we need to, in California. We have trouble with customs getting equipment from Canada to the States but since they have a distributor in Colorado they were able to ship it directly there and save us a bit of hassle.

“The data we collect is all non-invasive and we are collecting data on the astronauts who are on the station, which is downloaded to us straight away. So there is this benefit in the big field of telemedicine – how to obtain data from a distance, look at it somewhere else in the world and make a decision about the health of the individual. It’s a big field and we are only a small part of it but we are helping.”



Sandy Magnus

In addition to maintaining crew member health and pioneering telemedicine from space, the project does have a very earthly component. To study blood pressure on earth, sometimes it’s helpful to take gravity away, he says. Blood pressure dysregulation and hypertension are two obvious disease states of interest. “There are many different problems with blood pressure regulation, so to know how the system works as an integrated system between the nerves and the brain is important.

“What we are looking for is the weak link in that whole reflex loop – if we can identify that link that will be helpful.” Right now, he says, the culprit is looking very likely to be the blood vessels themselves.

Then there is the growing issue of physical deconditioning, particularly in the industrialised world. “If you think about cardiovascular disease and diabetes, the number one modifiable risk is physical inactivity, and this is associated with all of these deconditioning problems. It is primarily the cardiovascular system that is deconditioned so we are keeping one eye on the astronauts who are deconditioning for a variety of different reasons, but also because it affects the way they exercise – they don’t use their legs up there. So we are developing counter-measures and looking at them for other experiments.

“It’s pretty cool to be part of it,” he says. “It gains a lot of attention as space has a lot appeal to it, but it is difficult research to do and takes a lot of time. It’s not for the faint of heart.” **ALS**