

Patient Simulators Train Emergency Caregivers

NASA Technology

Medical training is one of the most important aspects of preparing astronauts for space. Every crewmember must become proficient in basic emergency skills, such as CPR, ventilation, and intubation. In the early 2000s, astronauts were being trained in Houston at Wyle Laboratories, the medical operations contractor for Johnson Space Center. At the time, the recent launch of the International Space Station (ISS) had ushered in an age of prolonged missions in low-Earth orbit. NASA wanted to be able to train crewmembers in a real microgravity environment because most actions to administer medical aid in weightless conditions required an adjustment from what is done on Earth.

Performing CPR is a prime example. The weight of one's body drives the compressions, but that force is nullified in microgravity. To compensate, astronauts in space must plant their feet onto the roof of the spacecraft to gain leverage and carry out the compressions while suspended upside down. Mastering such an atypical maneuver is best done through simulated practice.

Technology Transfer

Getting astronauts trained for these emergency scenarios meant having them practice on mannequins onboard a Boeing KC-135 Stratotanker, an aerial refueling military aircraft that, at the time, also moonlighted as a reduced gravity aircraft. Many who have ridden on one affectionately call it the "Vomit Comet." The plane simulates a microgravity environment by flying

CAE Healthcare's Emergency Care Simulator (ECS) is designed primarily for training first responders in CPR, ventilation, and intubation.

in a parabolic flight path, producing a series of 25-second stretches of weightlessness at a time.

For the mannequins, NASA Johnson Space Center turned to Sarasota, Florida-based METI (now CAE Healthcare), one of the nation's foremost developers of patient simulators. The company had gained recognition from the healthcare sector for developing the Human Patient Simulator (HPS)—a robust, high-fidelity mannequin used for medical training in intensive care and anesthesia. But this time NASA turned to the company's Emergency Care Simulator (ECS). Simplified and far more portable (its only external part is an "umbilical cord" that connects to a power and pneumatics box), the ECS was used in nursing schools and in emergency medicine training.

"As opposed to the HPS, with the ECS you're not dealing with a lot of medical monitors, ventilators or anesthesia machines," says CAE Healthcare director of engineering and innovation Hugo Azevedo, who worked with NASA on the project. "It's a simplified product designed to meet the training needs of first responders."

With the appropriate simulator chosen, the space agency wanted to make sure it could withstand the rigors of training and react appropriately in a space-like environment. In the fall of 2002, NASA entered into a Small Business Technology Transfer (STTR) agreement with METI to develop a microgravity-adapted ECS.

The ECS was modified in two important ways. The first were the adjustments made to account for the body's changes when exposed to microgravity. For example, aboard a spacecraft, astronauts tend to inhale more CO₂, so engineers tweaked the system's algorithms to account for how increased CO₂ inhalation and other factors would affect a person's physiology.

Then there was the issue of the simulator's sturdiness. When crewmembers practiced CPR on the ECS while flying in the KC-135, its arms would pop out of their sockets, the ribcage would be damaged, and the neck would flip around until it became detached, ruining the internal wiring. "They were putting quite a bit of force on the mannequins," Azevedo says. "You don't even realize how much force you're applying when you're in a non-gravity environment." To compensate for the increased exertion, stronger mounting structures were implanted to add rigidity and sounder structural integrity.

At the end of 2004, the modified ECS model was delivered to NASA, where it was used for training and for helping flight surgeons to keep their core competencies. The Agency also used the mannequin to help reconfigure an advanced life support procedure manual. "Using the ECS, crewmembers first walked through the procedure the way it was written, and then they followed the revised instructions," says NASA physiologist Victor Hurst IV. "Their feedback allowed us to revise the manual, and those same procedures are used onboard the ISS."



Benefits

The benefits of the NASA partnership didn't end with the space agency. The ruggedized features of NASA's ECS were made a permanent feature of the company's commercial line. In response, the military, namely the Army Medics and the Air Force's Critical Care Air Transport Team, has bought the ECS to train troops in real-life emergency scenarios without fear of breaking the equipment. Fire departments and other agencies that employ first responders have also used the product in simulated training environments.

In the years following, CAE Healthcare released newer products, including the iStan, a completely wireless patient simulator, and Caesar, which is specially designed for training in disaster response and combat casualty scenarios. Both were designed with ruggedized hardware as a result of the knowledge gleaned from improving the ECS.

Recalling the collaboration with NASA, Acevedo is clear about how important it was for furthering the development of both the technology and the firm. "It's paramount," he says. "I remember 10 years ago we were a fairly small company with fairly big aspirations, and these types of projects were very helpful. It gave us a financial balloon that allowed us to do a lot of development that we otherwise couldn't do." ❖

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NASA scientists onboard a reduced-gravity aircraft use the ECS to experiment with streamlining an airway management technique.

