Parabolic Flight Testing of Integration Zero-g Surgery Suite, Tools, and Fluids Separator

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Abstract

The integration of two spaceflight healthcare technologies previously proven operating independently in weightlessness was tested in parabolic flights in 2021 and 2022. One group of technologies combined a multi-function surgical suction wand with a surgical site containment dome attached to a wound model with simulated bleeding [1]. This surgical field was mounted inside a glovebox (with arm access ports for the surgeons) to provide secondary containment as successfully used in previous parabolic flights. The second technology is the passive zero-g blood-air separator that was proven in parabolic aircraft flights and commercial reusable sub-orbital rocket flights [2]. The surgical waste fluid from the wound model was suctioned into a collection reservoir, then pumped into the blood-air separator. Successful results from the interactive parabolic flight testing of the two systems creates a more complete zero-g surgical capability for exploration spaceflight beyond low Earth orbit.

Experiment

The flight experiment was funded by the NASA Flight Opportunities Program and has interactive and automated portions. The interactive portion is the surgical suite and tools from University of Louisville connected to a flattened version of the proven passive capillary-based blood-air separator from Purdue University and Orbital Medicine. A miniature momentary-contact switch was added to the suction wand so that the surgeon can easily control the suction system for surgical waste fluids during operations. Management of wounds with oozing or pulsating bleeding was studied in flight.

A companion experiment to the experiment described above is a second, independent fluids loop that studies how the separator functions for inflows of controlled liquid-air ratios. That is, from mostly blood to mostly air. This system senses 0g and 2g portions of the flight to adjust operations automatically. Data are visual and video observations of blood and air positioning in the separator during different levels of acceleration.

Conclusions

The integration of the two technologies proved successful, including surgeon control of on-demand suction to clear surgical fluids. The automated loop showed that the flattened air-fluid separator operated as intended in zero-g for all mixture ratios.

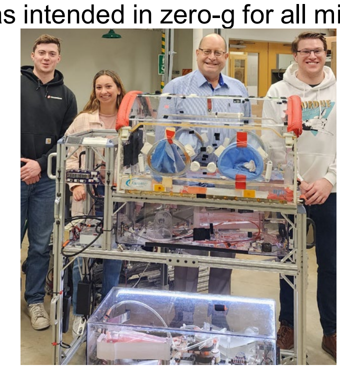

Figure 1: Nov 2022 hardware. Surgical suite (glovebox) is on the top and just below is the suction system for surgical testing. Transparent box at the very bottom houses the automated loop.

Figure 2. Flight team at work during a parabola. Researchers used foot straps or handles to remain in position during parabolas.

References

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