Surgical Capabilities Development for Reduced Gravity

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Introduction

The ability to surgically treat trauma and other disorders in reduced gravity requires reliable wound containment. The aqueous immersion surgical system (AISS) is a clear chamber attached to the skin over the surgical site that is filled with an immersion fluid (e.g. saline) to control bleeding, cleanse the wound, and maintain a clear visual field during surgical treatment (Figure, left). Parabolic flight testing of the AISS has been used for subsystem evaluation. Preparations for a suborbital flight automated evaluation of the integrated AISS fluid management system on the Virgin Galactic SpaceShipTwo are in preparation.

AISS Fluid Management System

The fluid management system (FMS, Figure, center) is used to control filling, purging of debris, provide therapeutic tamponade, and emptying of immersion fluid (saline) from the AISS dome by operating the coordinated action of pumps and valves with input from accelerometers, and pressure, flow, and optical sensors. Also incorporated is a 3-D printed, multi-function surgical wand that provides fluid suction and irrigation, as well as illumination via a fiber optic cable incorporated into the wall of the wand (Figure, right). Two different versions of the FMS are being evaluated. One version uses a National Instruments myRIO microprocessor to manage fluid in the rigid AISS dome. The compliant version of the AISS dome uses a Raspberry Pi microprocessor. Both versions control filling, pressure for therapeutic tamponade, purging, and emptying, while accommodating inputs and outputs of fluid via the multi-function wand. The ability for the FMS to correctly complete all functions in microgravity will be considered a success.

Experiment Protocol Initiation

High-definition surveillance cameras mounted inside the payload will record experiment status throughout the entire flight from takeoff to landing. Experiment initiation upon entry into microgravity occurs when the accelerometers in the myRIO microprocessor detect a sustained resultant acceleration of < 0.05 g. This experiment initiation strategy was validated during drop tower tests at the NASA Glenn Research Center.

Suborbital Flight Payload Container

A custom-designed glovebox, made of aluminum and polycarbonate, will contain the two different AISS evaluation experiments. The glovebox is the equivalent size of two stacked ISS stowage lockers (18.5" x 23" x 21.5") and contains 10" x 17" mounting boards for each of the AISS models to be evaluated. The glovebox features side doors that hinge down for experiment installation, servicing, and removal, as well as three pairs of arm access ports to permit interaction with the experiment by investigators during suborbital or parabolic flight. External electrical connectors are located in the front corners of the glovebox to receive spacecraft power that is distributed to the experiments inside of the glovebox via cable feed-through ports. The glovebox has undergone design review and performance testing to assure that it would provide adequate accommodation and secondary containment for the experiments and mate correctly to the payload mounting plate in the cabin of SpaceShipTwo.

Acknowledgement

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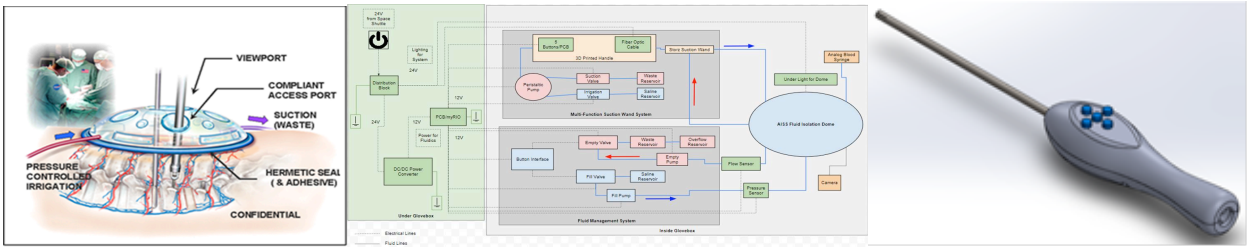

Figure Insert: AISS containment dome (left), FMS schematic (center), and surgical wand (right)