

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medical Care for Humans in Space (3)

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CREATING SURGICAL CAPABILITIES FOR EXPLORATION SPACEFLIGHT

Abstract

BACKGROUND: The NASA Human Research Program has identified a list of 100 medical conditions that astronauts may encounter in spaceflight; 26 of these conditions may include surgical treatment. The work of a project team at the University of Louisville to develop technology for surgical treatment in the reduced gravity of exploration spaceflight is presented. **OVERVIEW:** Initial efforts developed a transparent surgical containment dome with ports for leak-free trocars that can be placed over a site for surgical and wound treatment. A surgical fluid management system to be used with the containment dome to infuse irrigation solution into the dome, create a therapeutic tamponade to staunch bleeding, purge blood and debris to maintain good visualization of the surgical field, and empty the dome at the end of the procedure was evaluated using a bleeding wound model. The function of these devices in reduced gravity was evaluated in the reduced gravity of parabolic and suborbital flight. A multi-function surgical device that can provide suction, irrigation, illumination, visualization, and thermal cautery with finger-tip control was developed and tested in parabolic and suborbital flight. The 3D printing of surgical instruments was refined and the function evaluated in parabolic flight. The concept of a human-inspired, dexterous surgical/medical robotic assistant was demonstrated with NASA Robonaut 2 which could receive a verbal command, identify the request surgical instrument, grasp the instrument, and hand it to the surgeon making the request. Long-term preservation of red blood cells by for transfusion therapy has been developed using a dehydration process that minimizes injury to the cell membrane. The dehydrated red blood cells have demonstrated a stable shelf life for four years at room temperature before effective rehydration. A 360 virtual reality surgical video of the entire process of a laparoscopic appendectomy was produced to train and refresh non-surgical crew medical officers. **DISCUSSION:** Other research labs are developing imaging and anesthesia techniques compatible with exploration spaceflight among other resources needed to conduct a surgical procedure. These advancements presented above coupled with the efforts of other project teams will prepare exploration crew medical officers to provide surgical treatment when needed on the surface of the Moon or on the way to Mars.