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Medicine in Space and Extreme Environments (4)

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# DEVELOPING TELESURGERY-TELEANESTHESIA PROTOCOLS WITH SIMULATION-BASED TELEMENTORING IN REMOTE AND EXTREME ENVIRONMENTS AND FEASIBILITY IN INTEGRATING 3D PRINTED SURGICAL TOOLS, VRAR IMMERSION TO TRAIN NON-MEDICAL ANALOG ASTRONAUTS

**Abstract**

The development of novel medical technologies specifically design for exploration space missions can be solutions to address the myriad of medical challenges astronauts are currently faced with during short and long-duration missions including future planetary surface expeditions. Innovative, pioneering approaches incorporating exponential technologies will enable Humanity to not only survive but "thrive" in dangerous extreme environments on Earth, in Space, and for future settlement on Moon and Mars. Additionally, new discoveries and potential to improve "state-of-the art" medical procedures and protocols for training astronauts can be extrapolated for terrestrial "spin-off" benefits where the challenges found in the extraordinary environment of space can be used to change current accepted paradigms on

Earth. Our teams at Mars Academy USA, is currently developing teleanesthesia-telesurgery protocols using simulation-based telementoring platforms and real-time medical "tele-triage" operational procedures to train non-medical analog astronaut crews living in isolation and confinement in remote and extreme environments. Additionally, we have tested feasibility for incorporating exponential technologies, such as, 3D printed medical tools and VRAR technologies as possible fully immersive virtual tools to support the training. This abstract will highlight previous and on-going studies to address the challenges in providing space medicine interventions and emergency medical management for non-medical or minimally-trained medical crews. The study utilized real-time communication between remote medical teams and on-site non-medical trained analog astronauts. We tested 3D printed medical tools, such as, surgical scalpels and "VapoJet" device (a novel 3D printed portable anesthesia device) which can potentially replace the bulky anesthesia equipment currently used for in hospitals. During Mars Academy USA (MAU) simulation missions in low fidelity analog environments, crews were familiarized in basic teleanesthesia-telesurgical simulation protocols, such as, intubation procedures, use of Vapoject device, surgical suturing and debridement on training mannequins. Participants were observed by the remote medical teams composed of physicians and space medicine experts and scored using a modified OSAT (Objective Structured Assessment of Technical Skills). Participants were assessed on skills acquisition, surgical tool handling, skills retention, ease of integration of VRAR technologies. Video recordings were obtained for evaluation and participants completed subjective questionnaires. This ongoing project is planned for missions to mid-, and high fidelity analog environments to Kilimanjaro, Everest, and Antarctica. In summary, novel approaches can offer methodologies and innovations to develop new paradigms to train non-medical personnels not only for Space but also for poverty-stricken or under-developed regions on Earth where limited access to professional care-givers are still major challenges.