Medicine in the Final Frontier: Technologies to Enable Autonomous Prolonged (Field) Care in Space

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DESCRIPTION: The planning and execution of comprehensive "Prolonged Care" strategies are increasingly considered as fundamental operational concepts within the spheres of both military and non-military expeditionary medicine. Numerous advances in recent years have enabled the decentralization of health-related technology that has empowered medical - and even non-medical providers - to offer quality care farther afield and for increasingly extended periods of separation from traditional support structures. However, the operational concepts behind today's Prolonged Care paradigms are still largely dependent upon external support, including high-bandwidth telemedicine communications technologies (that allow ready access to centralized expertise), robust resupply pathways, and ultimately, on the timely evacuation of the sick and injured. What would happen if none of these support systems were readily available? Extremely remote Prolonged Care is one of the most significant challenges that the National Aeronautics and Space Administration (NASA) faces when preparing to expand human space exploration beyond the International Space Station (ISS) to deep space including the Moon and Mars. Continuous human presence on the International Space Station (ISS) in low Earth orbit for the past 20 years has demonstrated that indeed medical operations can be successfully executed with continuous real-time communications, frequent resupply missions, and the availability of rapid evacuation options. However, as time-distance factors from Earth increase with our pursuit and changing focus towards deep space missions, these resources and capabilities will no longer be available. As a result, space medicine operations will need to become more autonomous and less dependent upon mission support from Earth – requiring our attention and efforts to build robust capabilities that support the ultimate expression of the term "Prolonged Field Care."

CAPABILITIES: The group charged with enabling this shift for NASA is the Exploration Medical Capability (ExMC) Element of the NASA Human Research Program. The ExMC team is a multidisciplinary group of clinicians, scientists, and engineers whose shared goal is to advance medical system design for deep space exploration. ExMC supports developing, demonstrating, and adopting novel medical technologies that increase astronaut autonomy for exploration medical care to accomplish this goal. Many, if not all, of these capabilities, have direct terrestrial applications, particularly in the military Prolonged Field Care realm. This presentation will highlight a number of these NASA technologies and concepts, their applications, technology readiness levels, and transition strategies. Examples include software tools to guide astronauts with limited medical training through complex medical procedures, miniaturized point-of-care laboratory diagnostic equipment, a device that generates intravenous fluids from potable water, advanced clinical decision support tools, and a forecast of potential technological advances aimed at future long-duration exploration missions.

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OUTCOME: This presentation will outline the similarities between prolonged care in exploration spaceflight and expeditionary medical needs on Earth and provide examples of technologies that have applications in many different challenging environments.

Learning objectives:

1. Compare and contrast the provision of medical care in the space environment with terrestrial military environments.
2. Outline the challenges to successfully providing prolonged care in expeditionary medicine
3. Assess how technological advancements can enable increasingly autonomous prolonged care