IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medicine in Space and Extreme Environments (4)

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ADVANCED TECHNOLOGY FOR ENHANCING AUTONOMY IN SPACE MEDICINE

Abstract

INTRODUCTION: Exploration Class Missions require increased autonomy for crew medical care. Current protocols on the International Space Station favour supervised virtual care telemedicine which is appropriate given the minimal time delay and generally excellent communication capabilities. The cis-lunar environment will be associated with a 1.3 second time delay while Martian communication delays could range from 3-21 minutes with periods of total blackout. Given the increased difficulty of communication, the provision of onboard autonomous care will outweigh the mass, power, and volume impacts associated with Earth-based virtual care.

METHODS: We present a review of the current state of autonomous medical operations for space, the relevant medical literature, as well as anecdotal information from space-flown medical providers. Drawing parallels to remote and operational terrestrial environments, we will focus on the importance of autonomy in extreme and operational settings.

RESULTS: Current space medical operations heavily rely on telemedicine and telementoring of crew. The short training cycle for crew medical officers, the reliability of Earth-based communications and the possibility of urgent crew return supports the rationale for using this method for missions to low-Earth orbit. Deep space missions require a paradigm shift to respond to clinical events. While research is beginning to develop the autonomous tools for Earth-independent medical care, to date no clear set of requirements have been outlined. Augmented reality has been demonstrated to improve training cycles and provide benefit for just-in-time training and real-time guidance providing in-field autonomy for medical care.

CONCLUSION: Autonomous crew medical care will be required for deep-space missions. While cis-lunar missions may be achieved with Earth-dependant virtual care, it also provides an opportunity to develop technologies for truly autonomous care. For humans to leave the Earth-moon system, fully autonomous care will be critical to safely manage clinical problems as communication delays or blackouts eliminate the ability to manage medical concerns in real-time.