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CIS-LUNAR AND SURFACE MISSIONS: HEALTH RISKS AND POTENTIAL SURGICAL
CONDITIONS**Abstract**

The next goal of human space exploration is to return to the Moon to stay, and to establish a new, more advanced space station, the Lunar Gateway, in lunar orbit.

This paper is part of an ongoing exhaustive survey of relevant, published scientific literature to plan for medical conditions that might require operative or non-operative surgical solutions during long-duration spaceflight. Our aim is to create a roadmap for future mission planning. To date, we have identified more than 50 potential surgical conditions. Based on disease severity and mission duration, these can be classified into: (1) emergency conditions requiring immediate surgery; (2) urgent surgical conditions requiring minor temporising surgical intervention or conservative care (these patients can return to Earth for definitive treatment); or (3) delayable, as not immediately life threatening.

The proposed Lunar Gateway will be an international collaboration. Reaching the Gateway is anticipated to take about three days. The Gateway will operate in microgravity conditions, and include a communications lab (ground support from Earth is still available with minimal signal delay), a scientific lab, and a habitat for astronauts. Transfers to and from the lunar surface will allow for Extra-Vehicular Activities (EVA). Habitation on the Gateway will present similar physiological and psychological challenges as experienced on the International Space Station (ISS), with the addition of a slightly increased communications lag. The Moon is only within Earth's magnetosphere for approximately 25

Considering the length and distance of a lunar mission, emergency surgical interventions (1) will likely be necessary, such as treating a bowel perforation, or fixation for musculoskeletal trauma. Alternatively (2), antibiotic treatment of responsive appendicitis, drainage of uncomplicated cholecystitis, or other conservative measures might be acceptable as a temporising measure. If a return to Earth is possible within three days, delayed surgery can be undertaken if the conservative measures are not successful or there is a recurrence. In the case of procedures that can be delayed (3), planned evacuation to Earth will be available, for example, if a malignancy occurs.

Anticipating the medical and surgical challenges a Moon mission presents, and subsequent adequate planning and preparation for possible surgical emergencies, will help ensure mission success. Creating a system for triaging of surgical cases will be paramount.