

EFFECTS OF SPACEFLIGHT RELEVANT CARBON DIOXIDE LEVELS ON PATHOGENESIS RELATED MICROBIAL CHARACTERISTICS

S. G. Thornhill¹, A. A. Colorado², C. A. Nickerson^{3,4}, C. M. Ott⁵

¹JES Tech, Houston, TX, ²KBR, Houston, TX, ³School of Life Sciences, Arizona State University, Tempe, AZ, ⁴Biodesign Institute, Arizona State University, Tempe AZ, ⁵NASA Johnson Space Center, Houston, TX

Multiple stressors in the spaceflight environment, including microgravity and radiation, have the potential to alter microbial pathogenesis and virulence characteristics. Understanding how these and other factors may exacerbate the risk of infectious disease for astronauts is important to ensure the success of the mission. One understudied question in our assessment of infectious disease risk is the contribution carbon dioxide (CO₂) at atmospheric concentrations higher than would be observed in terrestrial settings. Previous terrestrial studies have shown altered gene expression, selective bacterial inhibition, increased growth and diversity, and increased antibiotic resistance of bacterial communities individually and in biofilms when exposed to increased levels of CO₂. While many of these findings are based on levels of CO₂ higher than would be found during spaceflight exploration missions, the potential for subtle changes in CO₂ levels to exacerbate infectious disease risks warrants an evaluation of pathogen responses to spaceflight CO₂ conditions.

To address this question, we are evaluating the effects of elevated atmospheric CO₂ on microbial concentration, diversity, and pathogenesis-related characteristics using medically significant microorganisms cultured at CO₂ levels representing terrestrial atmospheric concentration ($\approx 0.04\%$), ISS elevated concentration (0.4%), and an unexpectedly elevated concentration (1%) to represent a worst-case scenario. To determine if microbial responses to these CO₂ concentrations may be exacerbated in response to the spaceflight environment, microorganisms are being cultured under static conditions and both spaceflight analogue and control conditions using the Rotating Wall Vessel (RWV) bioreactor (Synthecon, Houston, TX). For these studies, we will evaluate the response of *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Enterobacter aerogenes*, which are opportunistic bacterial pathogens that are of medical significance and have been or are likely to be found aboard human-inhabited spacecraft. Bacteria will be evaluated individually and together as a consortium.

The following Specific Aims are being investigated:

Aim 1. Characterize the growth, diversity, and pathogenesis-related stress responses of medically significant microorganisms grown under multiple CO₂ concentrations under static growth in a liquid medium. Stress responses include acid stress, oxidative stress, and thermal stress.

Aim 2. Characterize the growth, diversity, and pathogenesis-related stress responses of medically significant microorganisms grown under multiple CO₂ concentrations in both spaceflight analogue and control conditions. Stress responses include acid stress, oxidative stress, and thermal stress.