Assessment of the adaptability of non-fastidious pathogenic bacteria to the Martian environment.

Tommaso Zaccaria [1,6], Marien De Jonge [2,3], Mihai Netea [2,4,5], Jorge Domínguez-Andrés [2-4], Marc Eleveld [2,3], Kristina Beblo-Vranesevic [6], Petra Rettberg [6].

[1] Radboud University, Nijmegen, Netherlands.
[2] Section Pediatric Infectious Diseases, Laboratory of Medical Immunology Department of Laboratory Medicine, Radboud University Medical Center, Nijmegen, Netherlands.
[3] Department of Internal Medicine, Radboud University Medical Center, Nijmegen, Netherlands.
[4] Radboud Institute for Molecular Life Sciences, Radboud University Medical Center, Nijmegen, Netherlands.
[5] Department of Genomics & Immunoregulation, Life and Medical Sciences Institute (LIMES), University of Bonn, Bonn, Germany.
[6] Research Group Astrobiology, Radiation Biology Department, Institute of Aerospace Medicine, Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Cologne, Germany.

Abstract

Understanding the extent to which non-fastidious pathogenic bacteria can survive in extraterrestrial conditions will help to improve astronaut safety. Despite stringent decontamination protocols, terrestrial microorganisms were previously found to travel on the bodies of astronauts, on spaceships and equipment. This might enable the microorganisms to adapt, grow and evolve in the new environment. In this study, we assessed the adaptability of clinically relevant bacteria species, which are able to grow on carbon-containing compounds identified in carbonaceous meteorites (*Klebsiella pneumoniae*, *Burkholderia cepacia*, *Serratia marcescens* and *Pseudomonas aeruginosa*), to the simulated Martian environment. Previous work has shown that bacterial survival and growth under these conditions led to the modification of their cell envelope, thereby altering their pathogenic potential. We continued with this line of research and explored the survival of these bacterial species to a range of simulated Martian conditions i.e., desiccation, UVC (254 nm) and polychromatic UV (200 - 400 nm) irradiation, growth in the presence of perchlorates, growth on Martian simulant and exposure to Martian atmospheric composition and pressure. Preliminary results showed that growth was enhanced by the addition of Mars Global simulant (mimicking Martian regolith) to the incubation media. Furthermore, these initial results showed that only two of the strains, *K. pneumoniae* and *S. marcescens* are tolerant to desiccation, up to 16 days. The UVC irradiation experiments have shown that the bacteria with the highest degree of survival are *P. aeruginosa* and *S. marcescens*. Likewise, the same two strains have shown higher survival rates compared to *K. pneumoniae* and *B. cepacia* when exposed to polychromatic UV irradiation. To investigate the consequences of survival and growth under simulated Martian conditions, on virulence and immune recognition, a follow-up study will analyze the response of immune cells placed in contact with bacteria exposed to the Martian environment. In addition, gene expression of the adapted bacteria will be further studied. This collaborative study between the DLR (German Aerospace Center) and the Radboud UMC, in the Netherlands has provided a starting point to the investigation into the adaptability of pathogenic bacteria to Martian conditions. Further studies are required in order to improve our insight on the effects of virulence and immune recognition of the exposed pathogens. This could enable us to potentially anticipate the risks of infection and inflammation during space-travel and exploration.