Opportunistic Pathogens in the International Space Station Drinking Water: Reason for Concern?

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Microbial examination of drinking water processed for International Space Station (ISS) confirmed the effectiveness of the Kennedy Space Center (KSC) biocide (iodine) treatment in removing all cultivable microbes. Untreated municipal water samples contained at least a one log higher magnitude of viable but non-cultivable (VBNC) microorganisms, not able to be detected with existing cultivation methods. Likewise, the humidity condensate portion of the ISS water, consumed by astronauts while rehydrating foods, contained VBNC microbes.

Molecular microbial community analyses of water processed at various stages for the STS-113 mission aboard the ISS retrieved ribosomal DNA sequences of opportunistic pathogens such as *Afipia, Deftia, Ochrobactrum, Propionibacterium,* and *Stenotrophomonas,* but did not confirm activity of these pathogens. However, evidence strongly suggests that implementation of new cultivation approaches to identify the presence of such pathogens is crucial. There is question as to whether the retrieval of opportunistic pathogen rDNA sequences in the ISS drinking water poses a threat to the health of astronauts. To answer this question the overall burden of opportunistic pathogens must be quantified and tested for viability and/or activity in the ISS drinking water. DNA-based TaqMan analyses effectively quantified the total bacterial burden of the ISS drinking water. In addition, suitable molecular methodologies were utilized to differentiate viable/active microbes from non-living ones. A species-specific DNA primer-probe set was designed and evaluated for one of the more prevalent opportunistic pathogens detected.

Water samples from various locations and sources about the ISS and space shuttle were collected and subjected to DNA extraction. Total bacterial and eukaryotic burdens were determined using TaqMan quantitative polymerase chain reaction (Q-PCR) procedures. Various microcosms artificially inoculated with aliquots of opportunistic pathogen isolated from the ISS drinking water (*Stenotrophomonas maltophila*) were prepared and exposed to several physical and nutrient-deprived stress conditions. By exploiting established Q-PCR protocols, viability and cellular activity were determined. Additional techniques, such as ATP-based measurement of total and viable microbial burden, were used to cross-validate these technologies. Stress-induced viability and changes in cultivability of *S. maltophila* were tracked microscopically as well as by conventional approaches to elucidate problems involved in culturing this opportunistic pathogen.