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PHARMACEUTICAL STABILITY AFTER EXPOSURE TO VACUUM

Abstract

To prepare for increasingly longer duration space missions where evacuation to earth is not an option, greater emphasis is being placed on non-invasive and pharmaceutical management of medical emergencies. Early investigations have highlighted the paucity of research on pharmaceutical stability and effectiveness in the space environment. Current literature explores factors such as radiation, vibration, humidity, temperature variations and concern for toxic degradation of products with little focus on vacuum exposure. According to several design reference missions for exploration spaceflight, the medical equipment storage area may be exposed to intermittent long periods of vacuum during transitional phases of spacecraft configuration. This study examines the effect of vacuum exposure on basic measures of pharmaceutical stability.

A literature review did not identify any evidence of pharmaceuticals being intentionally tested for stability of shelf life after vacuum exposure and repressurization. Anecdotal reports from Apollo missions suggest that outgassing and evaporations of solvents have been an issue in prior spaceflights, but were rendered inconsequential with Space Shuttle and ISS operating under a consistent near-normal pressure environment. To address this knowledge gap, four different physical types of medications (capsule, tablet, liquid spray, liquid adhesive) represented by common medications in current ISS medical kits (zaleplon, zolpidem, oxymetzoline and dermabond, respectably) were subjected to multiple 8-hour exposures in half vacuums (7psi/20,000 ft). These medications were weighed at atmospheric pressure, placed in a pressure vessel, and then removed to be re-weighed and inspected before being replaced in the pressure vessel for continued cycling. Different configurations of the four physical types of medications were used to investigate the potential role of sample age, packaging, and medication concentration. When left in their original packaging, there was no physical degradation or macroscopic change to the medications, including the capsule. In addition, there was no evidence of off-gassing or weight change of the liquid spray after the cap was removed, a test spray delivered, and then re-sealed between vacuum cycles. However, there was a 15% reduction in weight and evidence of barotrauma after exposure of a porous capsule removed from its original blister pack. Weights of the remaining items stayed within 2% of their base value. This work highlights the need for further research, particularly for experiments with repeated cycling over extended periods of time (weeks to months) as well as further investigation into the protective role of packaging, and testing to evaluate pharmacological effectiveness (ie preservation of active ingredient) of cycled products.