Immune Alterations in Rats Exposed to Airborne Lunar Dust
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Background  The lunar surface is covered by a layer of fine, reactive dust. Very little is known regarding the toxicity of lunar dust on human physiology. This study assessed the toxicity of airborne lunar dust exposure in rats on pulmonary and systemic immune parameters.

Methods  Rats were exposed to 0, 2.1, 6.8, 20.8 or 60.6 mg/m³ of respirable-size lunar dust for up to 4 weeks (6 h/day; 5 days/week). Intratracheal quartz (1 week) served as an experimental control. Subjects were then euthanized either 1 day, 1 week, 4 weeks or 13 weeks after the last exposure (Lam et al., Inhal. Toxicol. 25:661-678, 2013). Blood and lung lavage fluid samples were collected for analysis. Assays included leukocyte distribution by multicolor flow cytometry, electron/fluorescent microscopy, and lavage/plasma cytokine concentrations. Mitogen-stimulated cytokine production profiles were performed on whole blood samples only.

Results
- Untreated lavage fluid was comprised primarily of pulmonary macrophages.
- High-dose lunar dust inhalation (>20.8 mg/m³) resulted in an influx of neutrophils and lymphocytes. The T cell CD4:CD8 ratio was unchanged.
- Lavage fluid showed increased levels of IL-1β and TNFα. These alterations generally persisted through the 13 week sampling.
- Blood analysis showed that by week 4 the peripheral granulocyte percentage was elevated in the treated rats, however plasma cytokine levels were unchanged in all treated rats.
- Blood culture indicated mitogen-stimulated production of IL-1β and IL-6, and decreased IL-2.
- Minimal adverse immune effects observed in either lung or peripheral blood, following low-dose exposure to ≤6.8 mg/m³ lunar dust (data not shown).

Conclusion  Exposures to ≥20.8 mg/m³ lunar dust resulted in lung inflammation; dust uptake by pulmonary immunocytes, and some systemic immune dysregulation that did not subside even 13 weeks after the dust exposure. This information is beneficial in deriving an exposure limit of airborne lunar dust, and for spacecraft engineers considering dust mitigation systems in lunarlanders or habitats.