Microbiology and Crew Medical Events on the International Space Station

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Background

- The closed environment of the International Space Station (ISS) creates an ideal environment for microbial growth.
- Monitoring of air and surfaces for microbial growth on ISS began in 2000.
- Microbial counts are determined from samples collected and reported to ground. Samples are returned to the Microbiology Laboratory at JSC for bacterial and fungal identification.
- It is unknown if high microbial counts in the ISS environment are associated with in-flight medical events.

Purpose

To determine if an association exists between high air and surface microbial counts and inflight medical events onboard the ISS from 2000 to 2012 (Expedition 1 to Expedition 32).

Design and Methods

Microbiology Sampling

- Air and surface samples were collected quarterly by crew members.
- Common areas were sampled; assumed that all crewmembers were exposed where sampling was done.
- Crewmembers reported on a categorization based on the number of Colony Forming Units grown in sample.
- Samples are returned to earth for identification but this data was not used in the analysis.

Inflight Medical Events

- Sources of medical event information include: Electronic Medical Record and Private Medical Conferences.
- First 7 days of medical events were excluded from analysis due to potential confounding with Space Adaptation Syndrome.
- Only illness-related medical events were used in analysis.
- Medical events were analyzed by quarter on ISS to coincide with microbial sampling.

Analyses

- Descriptive analysis of medical events and microorganisms.
- Logistic regression models assessed relationship between high microbial counts and in-flight medical events.
  - Microbial events requiring remediation (cleaning) were not included in the analysis
  - Odds ratios were calculated
  - Controlled for effects of crew member during each calendar – quarter
  - Any astronaut who flew on more than one mission was treated as unique individuals in the analysis

Characteristics of Sample

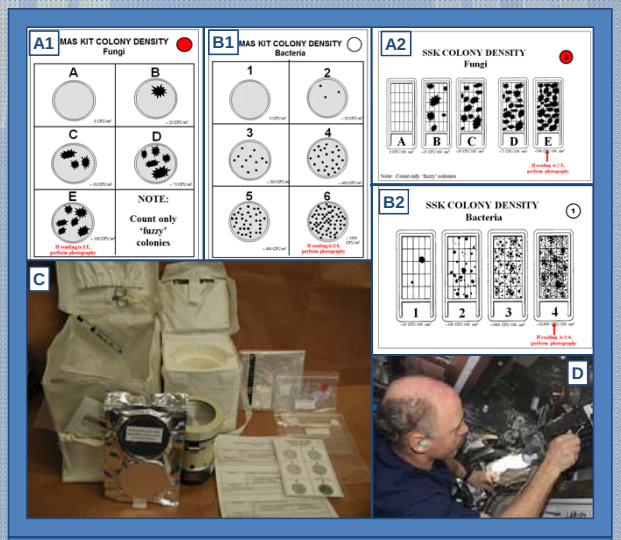
- 36 US Astronauts who flew at least one mission to ISS
- 5 crewmembers flew on 2 missions for an effective sample size of 41
- 8 women (2 repeat fliers), 28 men (3 repeat fliers)

Environmental Microbiology Data

Microbial monitoring of the spacecraft environment for high bacteria and fungi levels

Type of Sample	% at or above acceptability limit*
Air Fungi	20%
Air Bacteria	5%
Surface Fungi	23.9%
Surface Bacteria	21.7%

* Samples within or exceeding 1 step of the acceptability limit set in the Medical Operations Requirement Document (MORD) were used during analysis.



Microbial environmental sampling. Density charts are used during spaceflight to approximate the concentration of fungi (A) and bacteria (B) in the air (1) and surfaces (2). Specially designed flight hardware for air (C) and surface (D) sampling are used by crewmembers during flight.

Characteristics of Medical Events

- 78 in-flight medical events reported
- Types of medical events reported:
  - Skin rashes: tinea versicolor, aphthous ulcers, erythema, pruritus
  - Cold and allergy symptoms: nasal stuffiness, sneezing, cough, sore throat, eye irritation
  - Cold sores
  - Fever
  - Headaches
  - GI distress: gas, bloating, diarrhea, abdominal pain
  - Infections from cuts
- 27 of 41 crewmembers reported at least one medical event during their mission

Logistic Regression Results

Type of Sample	Odds Ratio	P
Any High Count	2.5604	.0172
High Air Fungi Count	0.9064	.8511
High Air Bacterial Count	0.8214	.8745
High Surface Fungi Count	2.1114	.0592
High Surface Bacterial Count	2.3681	.1344

Discussion

- During any given calendar-quarter on ISS, when a high microbial count was determined, there was a 2.5 times greater chance of an in-flight medical event being reported.
- High surface counts, bacterial or fungal, appear to contribute to a higher likelihood of a medical event than high air counts.
- Limitations:
  - Self-reported medical events by crewmember
  - Unable to determine counts by organism due to time lapse between sampling and specimen return to earth
  - Current analysis shows association between microbial counts and medical events, not a causal relationship

Future Goals

- Evaluate the relationship between medical events, high microbial counts and other factors such as vehicle docking and number of crew on station.
- Perform analysis of data using all events requiring remediation activities.

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