# Surveillance in a Telemedicine Setting: Application of Epidemiologic Methods at NASA Johnson Space Center

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## Introduction

Space medicine presents unique challenges and opportunities for epidemiologists, such as the use of telemedicine during spaceflight. Medical capabilities aboard the International Space Station (ISS) are limited due to severe restrictions on power, volume, and mass. Consequently, inflight health information is based heavily on crewmember (CM) self-report of signs and symptoms, rather than formal diagnoses. While CM's are in flight, the primary source of crew health information is verbal communication between physicians and crewmembers.

In 2010 NASA implemented the Lifetime Surveillance of Astronaut Health, an occupational surveillance program for the U.S. Astronaut corps. This has shifted the epidemiological paradigm from tracking diagnoses based on traditional terrestrial clinical practice to one that incorporates symptomatology and may gain a more population-based understanding of early detection of disease process.

## Methods

The study population was 37 NASA astronauts who flew on the ISS for Expeditions 1 – 28/29 (10/31/00–11/22/11). This represents 6,112 total days in space and 16.75 person-years. If an astronaut had more than one ISS flight during this timeframe, each mission was counted separately, resulting in 37 person-missions (28 men and 9 women).

The NASA Integrated Medical Model (IMM) is an operational tool that helps align science, technology, and operational activities. The IMM is used to optimize crew health and safety and ensure mission success by quantifying the probability and consequences of medical risks. IMM identified 100 medical conditions that may result in crewmember impairment, of which we identified 13 that may be associated with immune dysregulation (Table 1).

**Table 1: IMM Conditions (Expeditions 1 – 28/29 )**

| Medical Conditions | Total Events | Event / Flight Year |
|---|---|---|
| Allergic Reaction | 1 | 0.1 |
| Anaphylaxis | 0 | - |
| Upper Respiratory Infection | 0 | - |
| Eye Infection | 0 | - |
| Herpes Zoster | 0 | - |
| Otitis Externa | 0 | - |
| Otitis Media | 1 | 0.1 |
| Pharyngitis | 1 | 0.1 |
| Sepsis | 0 | - |
| Sinus Infection | 0 | - |
| Skin Infection | 3 | 0.1 |
| Skin Rash | 6 | 0.3 |
| Urinary Tract Infection | 0 | - |
| **Total** | **12** | **0.7** |

To evaluate additional indicators associated with immune precursors, we reviewed and expanded the IMM list to include signs and symptoms reported by crewmembers (Table 2). We reviewed all available sources of information including clinical records, Space Medicine Operations Team (SMOT) meeting minutes, a past integrated immune study survey, and postflight research debriefings.

Some overlap between categories was possible, depending on the specific symptoms. For all such instances, the epidemiologist and immunologist evaluators selected the single most appropriate category based on the event signs and symptoms reported. Events were not double-scored and we did not infer recurrence. If an event was noted as resolved by the flight surgeon or had a specific end date noted, and then a similar event occurred later in the mission, the events were tabulated as separate events. Observable symptom-events with causes other than immune dysregulation, such as intestinal complaints due to food, abrasions, or eye irritations/tearing were not included in this evaluation.

Events such as congestion, nausea, diarrhea or constipation that were reported and resolved within the first 30 days of flight were classified as due to space adaptation rather than immune dysregulation and were therefore excluded.

**Table 2: Symptoms and Conditions**
**Expeditions 1 – 28/29, N= 37 U.S. Crewmembers only**

| Medical Conditions and Symptoms | Total Events | Event / Flight Year |
|---|---|---|
| Allergic Reaction (Hypersensitivity) | 2 | 0.1 |
| Prolonged Congestion, Rhinitis, Sneezing | 11 | 0.7 |
| Herpesviruses (cold sores) | 6 | 0.3 |
| Ear Related Symptoms: Pain, Congestion, Itchiness | 4 | 0.2 |
| Pharyngitis (Sore throat) | 1 | 0.1 |
| Skin Infection (including pus forming wounds) | 5 | 0.3 |
| Skin Rash/Hypersensitivity (including skin conditions such as tinea versicolor, dermatitis, rosacea) | 21 | 1.2 |
| Urinary Tract Infection and/or symptoms | 2 | 0.1 |
| Infections and Other related symptoms (including fever, aphthous ulcer, lymphadenitis) | 4 | 0.2 |
| **Total** | **56** | **3.3** |
| 6112 total days in space, 16.75 person - years | | |

## Results

We identified 13 conditions from the IMM list that could be associated with dysregulated immunity during spaceflight. Table 1 reflects the incidence of the original 13 IMM conditions, while Table 2 shows the symptoms and conditions in this telemedicine environment.

## Conclusions

Using signs and symptoms reported via telemedicine and documented within patient medical records, we conducted a retrospective review and analysis. This approach has improved epidemiologists' ability to provide summary evidence regarding incidence of potential inflight medical conditions. These results inform our NASA physicians and researchers and support evaluation of the occupational health risks associated with spaceflight.

## Limitations

In the absence of a definitive resolution date or recurrence status by the physician, the criteria could be biased towards a higher frequency score.

## References

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