This Directed Acyclic Graph and write-up is an excerpt from a larger NASA document.

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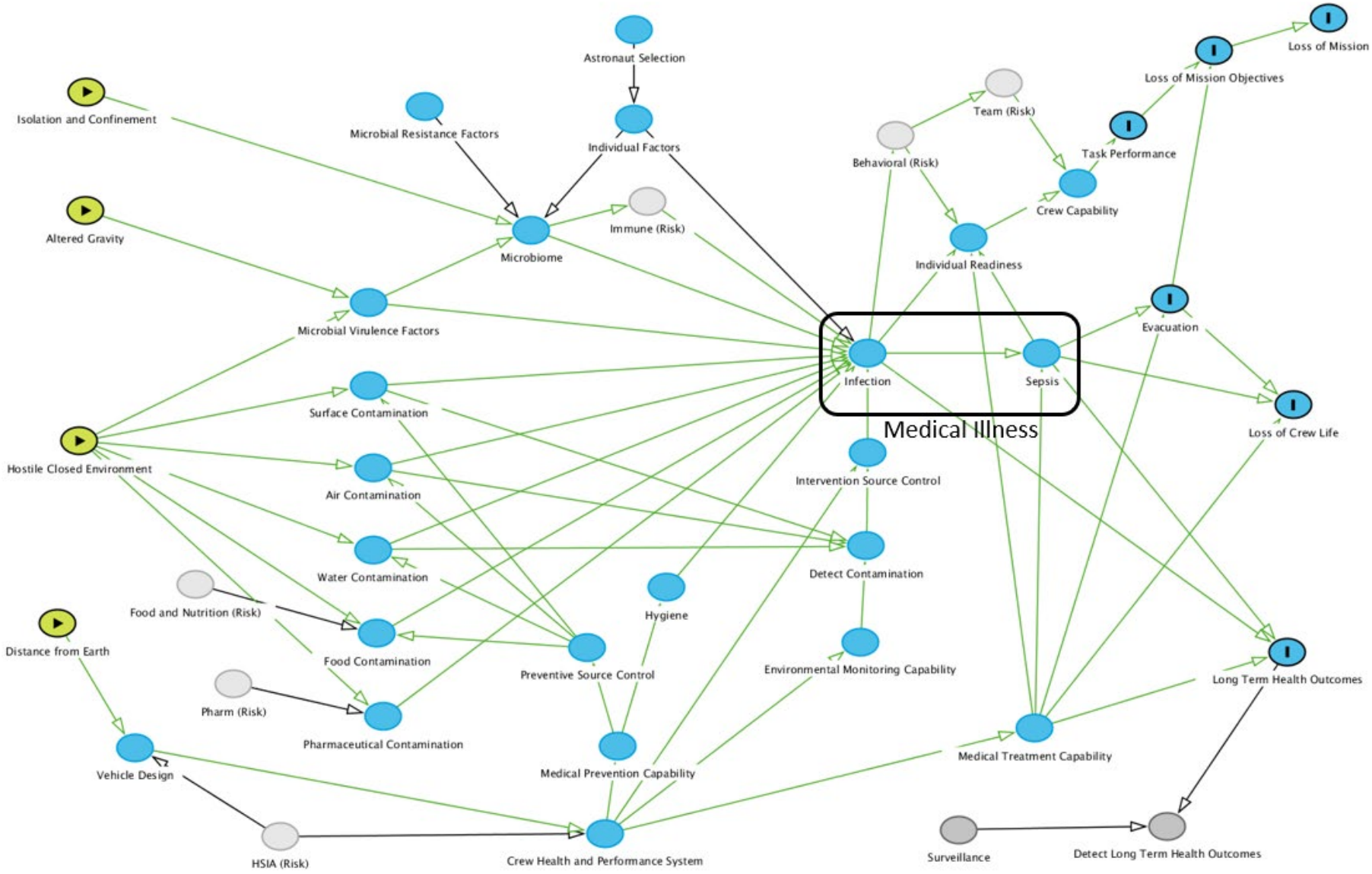
Directed Acyclic Graphs: A Tool for Understanding the NASA Spaceflight Human System Risks

Human System Risk Board

October 2022

Risk of Adverse Health Effects Due to Host-Microorganism Interactions (Microhost Risk)



Microhost Risk DAG Narrative

- The **Microhost Risk** centers around the possibility for microbial contamination leading to **Infections** that if left inadequately treated could become **Sepsis.** Both **Infections** and **Sepsis** can lead to deterioration of **Individual Readiness** and **Crew Capability** which affects **Task Performance**, likelihood of **Evacuation** for medical reasons, and in severe cases can contribute to **Loss of Crew Life**. They can also lead to **Long Term Health Outcomes** if inadequately treated and post-mission/career **Surveillance** enables **Detection of Long Term Health Outcomes** to understand the magnitude of the problem.
- The cause of infections can come from various sources:
  - **Microbial Virulence Factors** – evidence that the virulence of certain microbes change in response to spaceflight environment.
  - This may lead to an increased risk of infections.
  - Can indirectly lead to infections through changes in **Microbiome**.
  - **Immune (Risk) -** the strength of the immune system determines how well individuals fight off infections.
  - **Surface Contamination** - microbes on surfaces are found regularly on ISS, cleaning procedures can decrease impact on crew.
  - **Air Contamination** – good air quality and filtration can limit likelihood of airborne and droplet-based infections among crew.
  - **Water Contamination** - water quality monitoring and cleaning helps limit infections in crew.
  - **Pharmaceutical Contamination** - repackaged pharmaceuticals are susceptible to contamination increasing risk for infection among crew.
  - **Food Contamination** – inadequate packaging and storage conditions for crew food could lead to infections including gastroenteritis.
- Countermeasures that affect microbial levels must be included in the **Crew Health and Performance System** and accommodated in **Vehicle Design**. These are affected by the **HSIA (Risk)** and include: Countermeasures include the storage conditions which if compromised could increase contamination of food and pharmaceuticals; the storage conditions are also impacted by the food system available which is represented in the DAG by the **Food and Nutrition (Risk)**.
  - **Preventive Source Control** includes monitoring, regular cleaning, filtration and other modes of limiting spread of microbes.
  - **Hygiene** includes personal hygiene such as regular showers, dental hygiene, and other personal cleaning that limits the development of **Infection**.
  - **Environmental Monitoring Capability** is necessary to **Detect Contamination** levels in the air, water, and surfaces. This enables **Intervention Source Control** measures like cleaning or maintenance of filtration systems.
  - **Medical Treatment Capability** includes antibiotics, antifungal, and antiviral medications, as well as other supportive care, intended to minimize consequence of infection and prevent the development of sepsis.

- **Infections** and **Sepsis** affect cognitive function, mood and performance and therefore affect **Behavioral (Risk)** and **Team (Risk)** which negatively impacts **Individual Readiness** and **Crew Capability.**