# Behavioral Medicine and Team Risk Session

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>7.0</td>
<td>Risk of Behavioral and Psychiatric Disorders</td>
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<tr>
<td>22.0</td>
<td>Risk of Performance Errors Due to Poor Team Cohesion and Performance, Inadequate Selection/Team Composition, Inadequate Training, and Poor Psychosocial Adaptation</td>
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<tr>
<td>29.0</td>
<td>Risk of Acute or Late CNS Effects from Space Radiation</td>
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<tr>
<td>27.0</td>
<td>Risk of Performance Errors Due to Sleep Loss, Circadian Desynchronization, Fatigue, and Work Overload</td>
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<td>4.0</td>
<td>Risk of Inability to Adequately Treat an Ill or Injured Crew Member</td>
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<td>18.0</td>
<td>Risk of Therapeutic Failure Due to Ineffectiveness of Medication</td>
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<td>19.0</td>
<td>Risk of Error Due to Inadequate Information</td>
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<tr>
<td>34.0</td>
<td>Risk of Adverse Health Effects Due to Exposure to Hypoxic Environments</td>
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Risk 7.0  Behavioral Medicine Gaps

- Identify **behavioral characteristics that predict success** in an isolated, confined and extreme environment.
- Identify **methods to prevent, predict, and detect decrements in behavioral health** that affect performance during exploration missions.
- Identify **countermeasures for maintenance, restoration and enhancement** of behavioral health during exploration missions.
- Identify most appropriate and **effective ways for crews to use behavioral health medications** during exploration missions.
- Identify **methods to detect cognitive performance** changes during exploration missions.
Risk 22.0  Team Gaps

- Identify **serious threats to crew cohesion**, crew performance, and crew-ground interaction
- **Optimal ways to compose and train crews**, leaders, and ground support
- Identify ways to **monitor and measure crew cohesion**, crew performance, and crew-ground interaction
- Determine how **work autonomy** affects crew cohesion, crew performance, and crew-ground interaction
- Determine the **aspects of communication** that affect crew cohesion and performance
Maintaining Behavioral Health and Performance, and Crew Cohesion: Integrated Countermeasure Approach

**Prediction**
- Screen-in techniques and screen-out techniques based on phenotype
- Evaluation of response to training: Individuals and Teams
- Human Systems Integration Standards for psychosocial adaptation; medical standards, operational requirements for behavioral health and radiation protection

**Prevention**
- Operational training experiences (individual & group)
- Individual and team experiences in analog environments
- Practice in the use of self-test & detection technologies
- Training in use of detection and intervention countermeasures

**Detection**
- Monitoring crew cohesion, communication, problem solving, and relationship with MOD
- Monitoring individual stress, mood, fatigue & cognitive performance
- Objective assessment of neurocognitive functions
- Facilitating crew member’s private relationships with family and others

**Intervention**
- Facilitate crew-member’s private sessions with Psych Ops & Flt Docs
- On-board self-diagnosis and self-help technologies
- Crew rest and private time based prediction and detection of stress, fatigue, dysphoria
- Optimal (tailored) use of medications
7.0 Behavioral Medicine Projects

- Optical Computer Recognition of Behavioral Stress in Space Flight
  Dinges DF, Metaxas DN et al.

- Self-Guided Depression Treatment on Long-Duration Space Flights
  Cartreine JA, Buckey JC et al.

- Objective Detection, Evaluation & Countermeasures for In-flight Depression
  Strangman GE, Zeffiro et al.

- A Multimedia, Computer-based, Autonomous Stress and Anxiety Management Countermeasure for Long Duration Space Flight
  Rose RD, Cartreine JA et al.

- Countermeasures in Long Duration Spaceflight: Preventing Neurostructural Changes and Neurocognitive Decline in Crewmembers
  Otto CA

- Detecting the Effects of Neurobehavioral Function to Space Radiation
  Hienz RD, Roma P et al.

- Mental Representation of Spatial Cues During Spaceflight: An Update on the 3DSPACE Flight Experiment
  Lathan C et al.
Risk 22.0  Team Gaps

Antarctica Meta-Analysis – Psychosocial Factors Related to Long Duration Isolation and Confinement
Shea C, Leveton L et al.

Effects of High vs. Low Autonomy on Space Crewmember Performance: Results from Two Pilot Studies
Kanas NA, Neylan T et al.

Effects of Autonomous Versus Scheduled Mission Management in Simulated Space-Dwelling Groups Under Communication Constraints
Brady JV, Roma PG et al.

Enhancing Team Performance for Exploration Missions
Orasanu J, Fischer U et al.
**GOAL:** Develop machine vision that can track facial expressions for **stress, emotions and fatigue** unobtrusively over long duration missions.

- Detection of performance-induced stress
- Detection of emotional states (acute & chronic)
- Detection of fatigue (via Perclos = slow blinks)

**Risk areas 7 (BMed)**
**CRL= 4, TRL= 5**

- Laboratory experiments involving induction of stress, different emotions and fatigue to validate the fundamental accuracy of the OCR system (Penn).

- OCR algorithm development and image analysis at the Computational Biomedicine Imaging and Modeling Center (Rutgers).
Optical Computer Recognition (OCR) of Stress, Affect and Fatigue during Performance in Space Flight

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1Department of Psychiatry, University of Pennsylvania School of Medicine, Philadelphia, PA, USA.
2Department of Computer Science, Rutgers University, New Brunswick, NJ, USA.

Computational deformable tracker

Early version applied to ISS public video

Active Shape Modeling (ASM) based tracker

Estimated features from shape tracking
- \( F_1 \): tilting angle of head from horizontal line (\( \theta_1 \))
- \( F_2 \): left mouth corner slope from mouth shape center (\( -\theta_2 \))
- \( F_3 \): right mouth corner slope from mouth shape center (\( \theta_3 \))
- \( F_4 \): left eyebrow slope (\( -\theta_4 \))
- \( F_5 \): right eyebrow slope (\( \theta_5 \))

Lee C-S et al. Stress Analysis Using HMM and ASM Tracking (in prep)
OCR detector of facial expressions of stress was developed using a computational deformable model-based tracker and validated to be 73% accurate (vs 83% human accuracy)—further improvements underway. Computerized deformable mask was automated to track head and face movements in real time, using Hidden Markov Modeling and Active Shape Modeling. Recent improvements include (1) a single camera input, (2) automatic head tracking with a manifold of faces, (3) computational efficiency improved with Conditional Random Fields, and (4) GABOR filtering (used for edge detection in image analysis) was incorporated to track changes in facial texture, allowing it to identify new features for emotional expressions and fatigue.
Application development in near-infrared neuroimaging for spaceflight

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Why Scan the Brain in Space?

There is currently no way to directly assess the health or functional status of the brain during spaceflight, despite known biological and environmental risks:

- Radiation
- Sleep deprivation
- Toxic gasses (CO₂, CO)
- Chronic stress
- Injury

- Ischemia or hypoxia
- Nutrition changes
- Temperature extremes
- Dehydration/electrolyte imbalance

Adverse conditions → Altered brain function → Impaired performance
(1) Near-infrared Neuroimaging

- Lightweight
- Wearable
- Low-power
- Sensitive to cerebral blood oxygen/volume

OpticHolter 2a Prototype

Valsalva Maneuvers

Head Up/Down Tilt

905nm, 2.8cm
660nm, 2.8cm
(2) NIN for Functional Brain Recording

• Depression up-regulates brain activity.
• Up-regulation is normalized by cognitive therapy.

**Hypothesis:** NIN may provide a more objective measure of depression status.

Memory tasks with complex motor responses:
(3) Neural Performance Prediction

SpaceDOCK simulator

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<th>Sleep deprivation</th>
<th>Regional neural activity</th>
<th>Motor performance</th>
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<tbody>
<tr>
<td>$H_0$</td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>$H_a$</td>
<td>X $\rightarrow$ Mediator</td>
<td>$\rightarrow$ Y</td>
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Feb 2-4, 2009  NASA HRP Workshop  Strangman
Self-Guided Depression Treatment on Long-Duration Space Flights
Cartreine JA, Buckey JC et al.

A Multimedia, Computer-based, Autonomous Stress and Anxiety Management Countermeasure for Long-Duration Space Flight
Rose RD, Cartreine JA et al.

Virtual Space Station (VSS)

Developing self-directed, autonomous, interactive multimedia programs to train crewmembers how to recognize, assess, detect, prevent, and manage stress, anxiety and depression on extended spaceflights.

To evaluate the efficacy of the programs using objective indices of stress response with an analog astronaut sample of Navy Pilots at US Naval Center for Combat and Operational Stress Control in a randomized controlled trial with a comparison group.
Gaps:
BMed 1. Methods of preventing decrements in behavioral health affecting performance
BMed 4. What aspects of cognitive performance change during missions, do they persist?
Team 1. What are the most serious threats to crew cohesion & performance during exploration?
Team 3. What additional approaches would enhance current in-flight interventions & countermeasures for supporting crew cohesion & performance

Deliverables:
1. Comprehensive exercise regimen for all crew
2. Low fat, low refined sugar diet
3. Plant growth chamber (In-Flight & Terrestrial)
4. Regular video communication between crewmembers and family / friends
5. Cognitive skills assessment & retention program
6. Virtual reality vision environment
7. Video catalogue of cinema, sporting activity, Earth based flora & fauna