
2015 Behavioral Health and Performance Standing Review Panel

Evidence Review for:

The Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders, The Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team, and The Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload

Final Report

I. Executive Summary and Overall Evaluation

The 2015 Behavioral Health and Performance (BHP) Standing Review Panel (from here on referred to as the SRP) met for a site visit in Houston, TX on December 2 - 3, 2015. The SRP reviewed the Evidence Reports on the Risk of Adverse Behavioral Conditions and Psychiatric Disorders (BMed Risk), Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team (Team Risk), and Risk of Performance Errors Due to Fatigue Resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness, and Work Overload (Sleep Risk).

The BMed, Team, and Sleep Evidence Reports are all strong in presenting the Risks and Gaps in these particular areas. It is clear that a considerable amount of research has been conducted and/or funded by NASA and other sources to address the designated Risks and provide findings relevant to closing the specified Gaps. The Team and Sleep reports provide a clear and robust overview of the status of the evidence in their respective areas. In comparison, the BMed Evidence Report was significantly less clear and succinct and would be improved considerably with input from individuals with strong expertise in psychopathology. A change in focus to determining the presently subclinical signs of a disorder, rather than the emphasis on clinical diagnosis, is needed; as is acknowledgement of new paradigms for conceptualizing the multi-system nature of mental disorders and studying individual differences, such as the Research Domain Criteria (RDoC). The National Institute of Mental Health (NIMH) RDoC initiative highlights that it will be necessary to (1) determine the relationship between different units of analyses (i.e., between self-report, behavior, physiology, neural circuitry, genetics, and clinically relevant psychopathology); and (2) transcend traditional diagnostic groups to adequately capture the individual variability that can be mapped across units of analyses. An update of the relevant literature published in scientific venues is also important. Considering the small population of astronauts, all three evidence reports appropriately reflect a focus on the individual, including individual differences in personality traits and relationship to performance, the individual within the team, biomarkers of individual vulnerabilities and resiliencies, and individualized sleep medication.

Future research directions in planning for long-duration exploration missions are specified in all of the reports and provide a clear framework for filling current Gaps or addressing new Gaps that might become evident over time. In the BMed Evidence Report, this includes prospective studies of signs and symptoms of disorder in analog environments, best practices for psychotherapeutic treatment without real-time communication, development of a standardized set of research measures, and assessment of environmental effects on cognition and behavior.

The Team Evidence Report focuses on best practices in selection, composition, and communication skills training, unobtrusive monitoring technologies for detection of deteriorating team performance, and longitudinal designs. Future directions in the Sleep Evidence Report include a description of the nature of sleep on long-duration missions, and a better understanding of the factors that enhance or infringe on sleep and circadian disruptions in space.

Attention to interactions and integration within the BHP areas as well as other HRP areas is provided in the reports (e.g., sleep loss effects on team interactions and task performance; effects of sleep/alertness medications on task performance (Human Health Countermeasures [HHC])). However, further consideration of the interaction of space radiation on cognition and greater interaction with clinical pharmacology groups are recommended. A greater emphasis on leadership and the value of divergent thinking across the team also are topics recommended for further evaluation.

II. Review of the Evidence for the Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (BMed Risk)

1. *Evaluate the 2015 BMed Evidence Report using the following criteria:*

A. *Does the 2015 Evidence Report provide sufficient evidence that the Risk is relevant to long-term space missions?*

Yes. Sufficient evidence of the relevance of the BMed Risk is reported.

B. *Are the Risk Title and Statement properly stated in the current version of the HRP Integrated Research Plan (IRP)?**

Yes. The Risk Title and Statement are properly stated.

C. *Is the text of the Risk Context provided in the HRP IRP clear?**

Yes. The Risk Context is clear.

D. *Does the 2015 Evidence Report make the case for the research Gaps presented?*

Yes. The case is made for the research Gaps presented.

E. *Are there any additional knowledge-type Gaps or areas of fundamental research that should be considered to enhance the basic understanding of this specific Risk?*

Attention to recent developments in the conceptualization of psychopathology, such as the RDoC promulgated by the NIMH would add to the breadth of the report.

F. *Does the Evidence Report address relevant interactions between this Risk and others in the HRP IRP?*

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- Coverage of this topic is minimal; interactions specified are primarily within BHP (i.e., Sleep and Team areas).
 - Radiation and dopaminergic receptor interactions/influences on cognition, stress, should be examined.
 - The integration with Team and Sleep Risks is improving.

G. Is input from additional disciplines needed?

- Yes. Content on space radiation, psychopharmacology, and their influence on the BMed Risk is of particular interest.
- Closer collaboration with clinical personnel would be beneficial.

H. Is the expertise of the authors sufficient to fully cover the scope of the given Risk?

No. Input from a clinical psychologist or psychiatrist with strong expertise in psychopathology research and treatment is needed to provide additional perspective to the report.

I. Is there information from other HRP disciplines that need to be included in the 2015 Evidence Report?

- Human Health Countermeasures - pharmacology Risk overlap
 - More studies are needed to test drug administration and psychological reactions in microgravity.
 - Consideration of risk of psychosis with overuse of stimulant medications. How is psychosis being tracked in users of psychostimulants? Examination of the most sensitive psychometric measures to assess psychosis. The Profile of Mood States (POMS), indicated in the report, is not the best measure for this purpose.
- Interaction of Selective Serotonin Reuptake Inhibitors (SSRIs) and osteoporosis would be a good crossover area. Increased risk of fracture is important to the Exploration Medical Capability element (ExMC).
- Space radiation effects on cognition should be included.
- Habitability of the space vehicle in promoting/alleviating stress should be included.
- Interaction with ExMC on medical labeling and dispensing should be included.

J. Is the breadth of the cited literature sufficient?

- The review of the literature suffers from a lack of breadth.
- Numerous statements are anecdotal or poorly referenced.
- While it is understood that confidentiality prevents publication of psychological findings on astronauts, the points raised need to be grounded by some published evidence from other areas, or perhaps mentioned in terms of future directions of inquiry.

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- The review of the hardiness concept and supporting literature could be presented in greater depth. In the report this construct is discussed as a trait, but hardiness, and thus psychological resilience, is also influenced by training.

K. *What is the overall quality and readability of the 2015 Evidence Report?*

- The report does not demonstrate a deep knowledge of psychopathology and recent developments in this area.
- The biological/physiological aspects of psychopathology are superficially covered.
- A considerable number of research citations are from secondary and tertiary sources, including presentations given to internal NASA staff; original sources need to be cited when possible.
- In places, research findings are simply presented without synthesizing the findings in terms of meaning or applications.
- Conversely, in some sections, statements are made summarizing research findings without providing any references to back up these statements.
- Confidentiality is an issue when astronauts and cosmonauts are mentioned by name from sources other than an autobiography or biography.
- There is too much emphasis on “reported anecdotally” without specifying the source.

2. *Provide comments on any important issues that are not covered by the criteria in #1 above.*

- The statement on page 39 of the report about astronauts purposely providing wrong data could be rewritten in a more general manner.
- The focus in the evidence report, except for a paragraph in the last section, is on diagnosis, rather than the subclinical forms of disorders that are more likely to be evident in space flight.
- It is important to justify why delirium is listed as the most significant mental disorder likely to occur on a long-duration exploration mission.
- The asthenia section could be shortened considerably.
- A discussion of hardiness and resilience would require researcher Dr. Paul Bartone to adapt his model to the small pool of astronaut applicants in contrast to the large military pool he works with; there is also the question of whether hardiness can be enhanced through training.
- Findings on the Third Quarter phenomenon are *inconsistent* rather than *illusive* (or *elusive*).
- Speculation about astronaut resentment of payload specialists is tangential to the report.
- Discussion of astronaut select-in criteria: wouldn't *any* psychiatric diagnosis be a basis for exclusion?
- The Salyut crew likely suffered from shared beliefs and suggestibility rather than a shared hallucination in perceiving a smell on the spacecraft.
- Personal Characteristics Inventory (PCI) and “Right Stuff” personality configuration could be condensed; note that Instrumentality consists of two independent scales – Positive Instrumentality and Negative Instrumentality.
- Discussion of polar environments: some demands are different from space demands.
- Questionable assumption is made that more autonomy is always beneficial.

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- Anxiety is not a mood disorder.
 - Russian cosmonaut Valerie Polyakov was the first to spend more than one year in space. His name was omitted from the discussion and table on this topic.
 - Include definitions of Categories I-IV in an Appendix.
 - Table 1 – indicate in a footnote the number scheme used.
 - Acceptance of loose anecdotal evidence may preclude the possibility of publishing the Evidence Report in a peer-reviewed journal, which would be beneficial.
 - An important aspect for assessment of astronauts is respondent burden. The *PROMIS*® (Patient Reported Outcome Measurement Information System) measures (<http://www.nihpromis.org>; (Cella, Riley et al. 2010, Gershon, Rothrock et al. 2010) were explicitly developed to reduce respondent burden. PROMIS is a U.S.-based cooperative group of research sites and centers of excellence, funded by NIH, and convened to develop and standardize patient outcome measures across studies and settings. The PROMIS measures were developed using item response theory and calibrated on a sample of 21,133 people, with the aim of providing highly reliable, precise measures of patient-reported health status for physical, mental, and social well-being. Most question banks utilize a seven-day recall period (inquiring about events in the past seven days) and five response options (e.g., 1=Not at all, 5=very much). All instruments were developed to be used with computer adaptive testing (CAT) to reduce respondent burden. With this method, an average of five items is administered for each PROMIS construct listed, taking an estimated 1-minute or less to complete.

III. Review of the Evidence for the Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team (Team Risk)

1. *Evaluate the 2015 Team Evidence Report using the following criteria:*

A. *Does the 2015 Evidence Report provide sufficient evidence that the Risk is relevant to long-term space missions?*

Yes. The Team Risk evidence is sufficiently stated.

B. *Are the Risk Title and Statement properly stated in the current version of the HRP Integrated Research Plan (IRP)?**

Yes. The Risk Title and Statement are properly stated.

C. *Is the text of the Risk Context provided in the HRP IRP clear?**

Yes. The text of the Risk Content is clear.

D. *Does the 2015 Evidence Report make the case for the research Gaps presented?*

Yes. “Algorithms needed to compose a team” is a positive step.

E. Are there any additional knowledge-type Gaps or areas of fundamental research that should be considered to enhance the basic understanding of this specific Risk?

- Use of a different methodology (algorithms needed to compose a team) is a plus.
- Trait configurations within a single individual with regard to effects on team interactions (e.g., high extraversion combined with high agreeableness) can be positive.
- Look beyond personality variables for individual differences and skills that contribute to team effectiveness.
- Possibility of the development of a romantic relationship during the mission needs consideration in terms of effects on power dynamics within the team.
- Rotation of membership in mission control also is a research area yet to be examined.
- Value of divergent thinking across the team.
 - Team task analysis – when thinking together, diversity of opinion is important as well as cohesion. Is NASA looking at cohesion to the detriment of divergent thinking? Level of interdependence of team members?
- Effects of increased autonomy and communication delays on increases in team interdependence are of interest.
- Effects of increased autonomy and communications delays on team power dynamics also is a leadership issue of interest.
- In general, leadership themes should be emphasized.

F. Does the Evidence Report address relevant interactions between this Risk and others in the HRP IRP?

Joint research with sleep is impressive. Circadian rhythm/team connections research is very nice start and should be expanded.

G. Is input from additional disciplines needed?

Not at the present time.

H. Is the expertise of the authors sufficient to fully cover the scope of the given Risk?

This is a very nice and well-written report which reflects the authors’ strong expertise.

I. Is there information from other HRP disciplines that need to be included in the 2015 Evidence Report?

Not at present.

J. Is the breadth of the cited literature sufficient?

Leadership themes should be emphasized in this area, including literature citations.

K. What is the overall quality and readability of the 2015 Evidence Report?

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- Excellent.
 - Include definitions of Categories I-IV in an Appendix.

2. *Provide comments on any important issues that are not covered by the criteria in #1 above.*

The Team Evidence Report is clearly written; examination of the literature and issues related to Team Gaps are well presented.

IV. Review of the Evidence for the Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload (Sleep Risk)

1. *Evaluate the 2015 Sleep Evidence Report using the following criteria:*

A. *Does the 2015 Evidence Report provide sufficient evidence that the Risk is relevant to long-term space missions?*

Yes. The text of the Sleep Evidence Report provides sufficient evidence of the relevance of the Risk.

B. *Are the Risk Title and Statement properly stated in the current version of the HRP Integrated Research Plan (IRP)?**

The title is fine, but the SRP would still like to see “work overload” removed from the title and statement. While peripherally related, work overload is a distinct construct that has implications for BMed and Team as well.

C. *Is the text of the Risk Context provided in the HRP IRP clear?**

“Work overload” should be removed from the Risk Context as it seems to be an indirect issue.

D. *Does the 2015 Evidence Report make the case for the research Gaps presented?*

Yes. The case is adequately made for the research Gaps presented.

E. *Are there any additional knowledge-type Gaps or areas of fundamental research that should be considered to enhance the basic understanding of this specific Risk?*

- The effect of stimulant use on sleep should be considered in the Sleep Risk (possible crossover with BMed/Pharmacology). Given that astronauts report using stimulants on occasion, the effect of these medications is an important area of fundamental research.

F. *Does the Evidence Report address relevant interactions between this Risk and others in the HRP IRP?*

- More interactions with clinical pharmacology would be useful (i.e., newly developed medications, interactions with other medications likely to be used in space, delivery mechanisms, pharmacodynamics, and pharmacokinetics).
- Greater focus is recommended on effects of sleep on team psychosocial processes because of changes in emotional self-regulation.

G. *Is input from additional disciplines needed?*

- Stimulants should be considered in the Sleep Risk (possible crossover with BMed/Pharmacology).

H. *Is the expertise of the authors sufficient to fully cover the scope of the given Risk?*

- Yes. The addition of Dr. Erin Flynn-Evans adds further strength to the group.

I. *Is there information from other HRP disciplines that need to be included in the 2015 Evidence Report?*

- Greater focus on effects of sleep on team psychosocial processes because of changes in emotional self-regulation.

J. *Is the breadth of the cited literature sufficient?*

- Yes.

K. *What is the overall quality and readability of the 2015 Evidence Report?*

- Excellent.
- Include definitions of Categories I-IV in an Appendix.

2. *Provide comments on any important issues that are not covered by the criteria in #1 above.*

- The group was very responsive to comments from the previous SRP.
- The SRP is particularly impressed with the translation of research knowledge into public, peer-reviewed literature by the Sleep group.
- Integration with latest terrestrial literature and the sleep and circadian rhythm scientific communities at meetings/conferences could be improved. Extramural reports are a positive step.

V. 2015 BHP SRP Evidence Review: Statement of Task for the Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders, the Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team, and the Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload

In 2008, the Institute of Medicine (IOM) reviewed NASA's Human Research Program (HRP) Evidence Books that describe the Risks that were identified in NASA's Human Research Program Requirements Document (PRD). The 2015 Evidence Reports for the Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders (BMed Risk), the Risk of Performance and Behavioral Health Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team (Team Risk), and the Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload (Sleep Risk) have not been reviewed since the last IOM review and there have been significant changes to the evidence base for these Risks.

The 2015 Behavioral Health and Performance (BHP) Standing Review Panel (SRP) is chartered by the Human Research Program (HRP) Chief Scientist to review the updated Evidence Reports for the BMed, Team, and Sleep Risks. The 2015 BHP SRP will evaluate the Evidence Reports and generate a final report of your analyses of the evidence base, including any recommendations on how to improve the current Evidence Report, and submit it to the HRP Chief Scientist. Your report will also be made available on the Human Research Roadmap (HRR) website.

The 2015 BHP SRP is charged to:

1. Evaluate the 2015 BMed, Team, and Sleep Risks Evidence Reports based on each of the following criteria:
 - A. Does the 2015 Evidence Report provide sufficient evidence that the Risk is relevant to long-term space missions?
 - B. Are the Risk Title and Statement properly stated in the current version of the HRP Integrated Research Plan (IRP)?*
 - C. Is the text of the Risk Context provided in the HRP IRP clear?*
 - D. Does the 2015 Evidence Report make the case for the research Gaps presented?
 - E. Are there any additional knowledge-type Gaps or areas of fundamental research that should be considered to enhance the basic understanding of this specific Risk?
 - F. Does the Evidence Report address relevant interactions between this Risk and others in the HRP IRP?
 - G. Is input from additional disciplines needed?
 - H. Is the expertise of the authors sufficient to fully cover the scope of the given Risk?
 - I. Is there information from other HRP disciplines that need to be included in the 2015 Evidence Report?

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- J. Is the breadth of the cited literature sufficient?
 - K. What is the overall quality and readability of the 2015 Evidence Report?

2. Provide comments on any important issues that are not covered by the criteria in #1 above.

** Please be aware that any suggested changes to the Risk Title, Statement, and Risk Context by the SRP may need to be approved by the Human Systems Risk Board (HSRB). The HSRB has the overall responsibility to implement and maintain a consistent, integrated process for assessing, documenting, and tracking all risks to the human system associated with spaceflight activities (both in flight and post flight).*

Additional information regarding this review:

1. Attend a meeting at the NASA JSC on December 2 – 3, 2015 to discuss the Evidence Reports with the BHP Element. At this meeting, prepare a draft report that addresses each of the evaluation criteria listed in the panel charge (A-K) including any recommendations on how to improve the Evidence Reports. Debrief the HRP Chief Scientist (or designee) and a representative from the BHP Element on the salient points that will be included in the final report and specifically the items in the panel charge.
2. Prepare a draft final report within one month of the meeting that contains a detailed evaluation of the Evidence Reports specifically addressing items #1 and #2 of the SRP charge. The draft final report will be sent to the HRP Chief Scientist and he will forward it to the appropriate Element for their review. The BHP Element and the HRP Chief Scientist will review the draft final report and identify any misunderstandings or errors of fact and then provide official feedback to the SRP within two weeks of receipt of the draft report. If any misunderstandings or errors of fact are identified, the SRP will be requested to address them and finalize the 2015 SRP Final Report as quickly as possible. The 2015 SRP Final Report will be submitted to the HRP Chief Scientist and copies will be provided to the BHP Element and also made available to the other HRP Elements. The 2015 SRP Final Report will be made available on the HRR website (<http://humanresearchroadmap.nasa.gov/>).

To clarify, the Risk Statement and Risk Context are defined as follows:

Risk Statement:

“Given the CONDITION, there is a possibility that a CONSEQUENCE will occur”.

Condition: a single phrase briefly describing current key circumstances, situations, etc. that are causing concern, doubt, anxiety, or uncertainty – something that keeps you up at night.

Consequence: a single phrase or sentence that describes the key, negative outcome(s) of the current conditions.

Notes:

The condition-consequence format provides a more complete picture of the Risk, which is critical during mitigation planning. The condition component focuses on what is currently causing concern. This is something that is true or widely perceived to be true. This component provides information that is useful when determining how to mitigate a Risk.

The consequence component focuses on the intermediate and long-term impact of the Risk. Understanding the depth and breadth of the impact is useful in determining how much time, resources, and effort should be allocated to the mitigation effort.

A well-formed Risk Statement usually has only one condition, and has one or more consequences.

Risk Context:

Purpose: provide enough additional information about the Risk to ensure that the original intent of the Risk can be understood by other personnel, particularly after time has passed.

Description: capture additional information regarding the circumstances, events, and interrelationships not described in the Risk Statement.

An effective context captures the what, when, where, how, and why of the Risk by describing the circumstances, contributing factors, and related issues (background and additional information that are NOT in the Risk Statement).

VI. 2015 BHP SRP Roster

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