

National Aeronautics and Space Administration



A Third-Generation Evidence Base for Human Spaceflight Risks

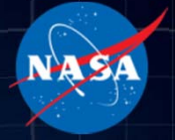
Aerospace Medical Association
85th Annual Meeting

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Neal Pellis, PhD
John Charles, PhD

12 May 2014



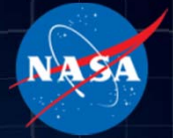
Disclosure Information



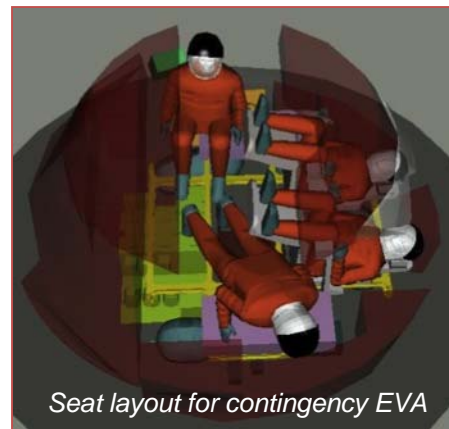
I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use in my presentation

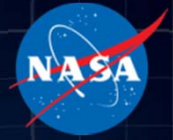
Human Research Program Goal



The goal of HRP is to provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration.

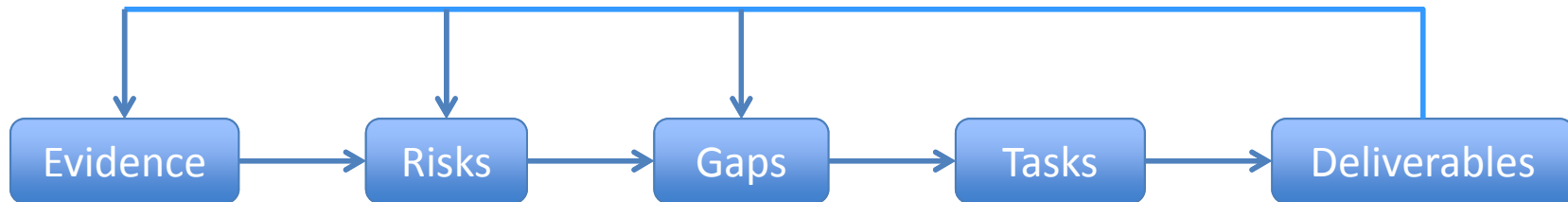
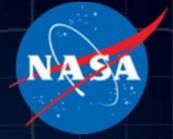


HRP Risks

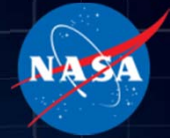


1. Risk Factor of Inadequate Nutrition
2. Risk of Acute and Late Central Nervous System Effects from Radiation Exposure
3. Risk of Acute Radiation Syndromes Due to Solar Particle Events (SPEs)
4. Risk of Adverse Behavioral Conditions and Psychiatric Disorders
5. Risk of Adverse Health Effects Due to Alterations in Host-Microorganism Interactions
6. Risk of Adverse Health Effects of Exposure to Dust and Volatiles During Exploration of Celestial Bodies
7. Risk of an Incompatible Vehicle/Habitat Design
8. Risk of Bone Fracture
9. Risk of Cardiac Rhythm Problems
10. Risk of Clinically Relevant Unpredicted Effects of Medication
11. Risk of Compromised EVA Performance and Crew Health Due to Inadequate EVA Suit Systems
12. Risk of Crew Adverse Health Event Due to Altered Immune Response
13. Risk of Decompression Sickness
14. Risk Of Degenerative Tissue Or Other Health Effects From Radiation Exposure
15. Risk Of Early Onset Osteoporosis Due To Spaceflight
16. Risk of Impaired Control of Spacecraft, Associated Systems and Immediate Vehicle Egress Due to Vestibular/Sensorimotor Alterations Associated with Space Flight
17. Risk of Impaired Performance Due to Reduced Muscle Mass, Strength and Endurance
18. Risk of Inadequate Critical Task Design
19. Risk of Inadequate Design of Human and Automation/Robotic Integration
20. Risk of Inadequate Human-Computer Interaction
21. Risk of Injury from Dynamic Loads
22. Risk of Intervertebral Disk Damage
23. Risk of Orthostatic Intolerance During Re-Exposure to Gravity
24. Risk of Performance Decrement and Crew Illness Due to an Inadequate Food System
25. Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team
26. Risk of Performance Errors Due to Fatigue Resulting from Sleep Loss, Circadian Desynchronization, Extended Wakefulness, and Work Overload
27. Risk of Performance Errors Due to Training Deficiencies
28. Risk of Radiation Carcinogenesis
29. Risk of Reduced Physical Performance Capabilities Due to Reduced Aerobic Capacity
30. Risk of Renal Stone Formation
31. Risk of Spaceflight-Induced Intracranial Hypertension/Vision Alterations
32. Risk of Unacceptable Health and Mission Outcomes Due to Limitations of In-flight Medical Capabilities

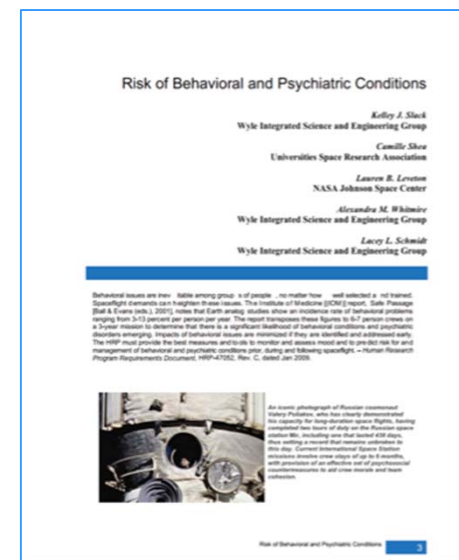
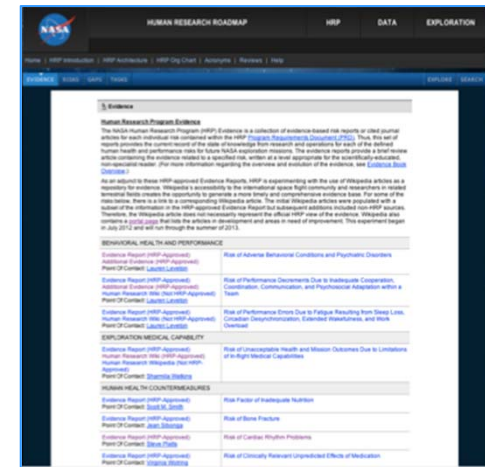
Program Architecture

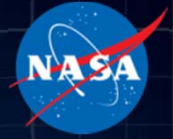


First Generation Evidence Base



- 2008 Evidence Book
 - One volume
 - One chapter for each HRP risk
 - Review paper format
 - Aimed at scientifically-educated, non-specialist reader
 - Current state of knowledge from both research and operations
 - Authors
 - Human Research Program
 - National Space Biomedical Research Institute
- Chapters linked to their risk on HRP website
 - humanresearchroadmap.nasa.gov/Evidence/

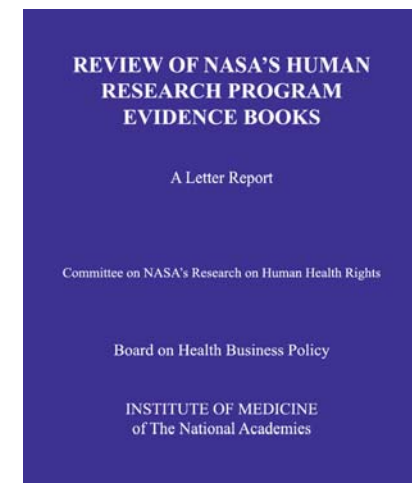




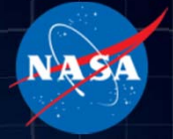
- The February 2008 versions of the Evidence-Based Risk Reports were reviewed by members of a committee on NASA's Research on Human Health Risks, established by the Institute of Medicine.
- The resulting thorough *Review of NASA's Human Research Program Evidence Books: A Letter Report (2008)* provided outstanding guidance for both the revision of the current risk reports and for the development of future versions.

humanresearchroadmap.nasa.gov/reviews/IOM%20Review.pdf

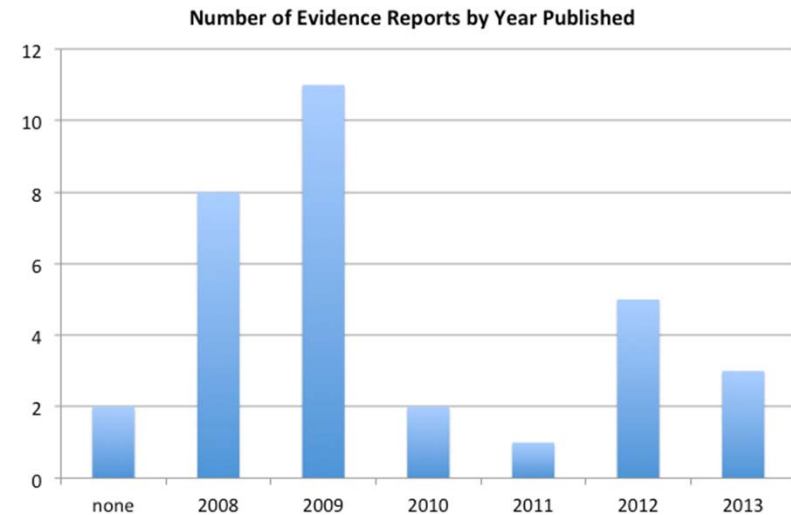
- This review also offered excellent suggestions to improve public access to the information in these reports.



Limitations of the 1GEB

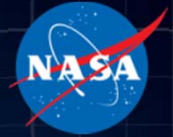


- Limited authorship
 - NASA and NSBRI
 - Missing ISS international partners
 - Missing researchers studying related terrestrial issues
- Laborious update process
 - Resulting in “all or none” updates
- Infrequent updates



Note: Some Evidence Reports have been supplemented by a bibliography or additional report

The Second Generation Evidence Base - Wikipedia



- The Gene Wiki precedent

- Enable the creation of a collaboratively written, continuously updated, high quality review article for all (~25,000) human genes.
- Wikipedia
 - “Stub” articles for each gene in standardized format
 - Users add and refine content
 - en.wikipedia.org/wiki/Gene_Wiki

- The HRP implementation

- Portal page in Wikipedia
- Main article for each Risk
 - Subarticles as needed
 - Links to related Wikipedia content
 - Summary of HRP-approved Evidence Report

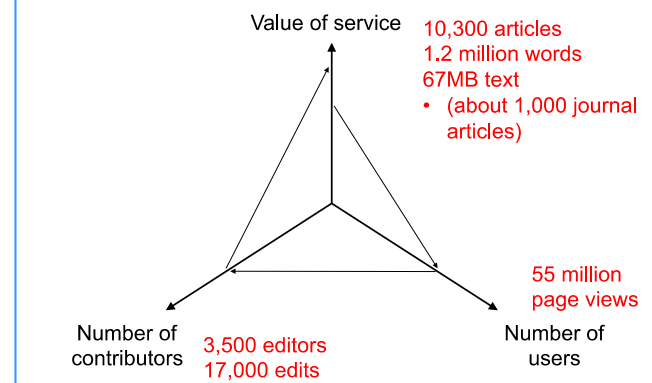
A review article for every gene is powerful

68 editors, 543 edits (as of July 2010)

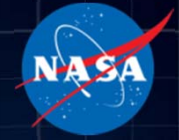
References to the literature

Hyperlinks to related concepts

The Gene Wiki project – 2010 stats



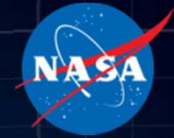
The HRP Portal



The screenshot shows a web browser window displaying the Wikipedia page for the Portal:Human Health and Performance in Space. The browser's address bar shows the URL: en.wikipedia.org/wiki/Portal:Human_Health_and_Performance_in_Space. The page features a navigation menu with options like 'Portal', 'Talk', 'Read', 'Edit', and 'View history'. A search bar is also present. The main content area includes a 'Welcome' section with a paragraph describing the portal's purpose and a list of 'Topics' such as 'Fatigue and Sleep Loss During Spaceflight' and 'Treating An Ill or Injured Crew Member In Space'. A 'How you can help' section provides links to edit and contribute to various articles. A notification box at the top indicates a suggestion to merge the page into 'Portal:Spaceflight'. The left sidebar contains the standard Wikipedia navigation links, including 'Main page', 'Contents', and 'Interaction'.

http://en.wikipedia.org/wiki/Portal:Human_Health_and_Performance_in_Space

A Wikipedia entry



W Visual impairment due to x

en.wikipedia.org/wiki/VIIIP

NHC BoA Discover Google News NWS Weather Weather Channel Email JSC Inside JSC Webmail Bookmark Manager Other Bookmarks

Create account Log in

Article Talk Read Edit View history Search

WIKIPEDIA
The Free Encyclopedia

Main page
Contents
Featured content
Current events
Random article
Donate to Wikipedia
Wikimedia Shop

Interaction
Help
About Wikipedia
Community portal
Recent changes
Contact Wikipedia

Toolbox
Print/export

Visual impairment due to intracranial pressure

From Wikipedia, the free encyclopedia
(Redirected from VIIIP)


Spaceflight induced **Visual impairment** is hypothesized to be a result of increased **intracranial pressure**. The study of visual changes and **intracranial pressure (ICP)** in astronauts on long-duration flights is a relatively recent topic of interest to Space Medicine professionals. Although reported signs and symptoms have not appeared to be severe enough to cause blindness in the near term, long term consequences of chronically elevated intracranial pressure is unknown.^[1]

NASA has reported that fifteen long-duration male astronauts (45–55 years of age) have experienced confirmed visual and anatomical changes during or after long-duration flights.^[2] **Optic disc edema**, globe flattening, **choroidal folds**, **hyperopic shifts** and an increased intracranial pressure have been documented in these astronauts. Some individuals experienced transient changes post-flight while others have reported persistent changes with varying degrees of severity.^[3]

Although the exact cause is not known at this time, it is suspected that microgravity-induced cephalad fluid shift and comparable physiological changes play a significant role in these changes.^[3] Other contributing factors may include pockets of increased CO₂ and an increase in sodium intake. It seems unlikely that resistive or aerobic exercise are contributing factors, but they may be potential countermeasures to reduce intraocular pressure (IOP) or intracranial pressure (ICP) in-flight.^[2]

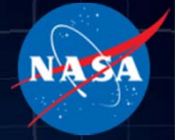
Contents [hide]

- Causes and current studies
 - CO₂
 - Sodium Intake
 - Exercise
 - Biomarkers
 - One-Carbon Metabolism (Homocysteine)
 - Space Obstructive Syndrome
- Current ICP and IOP Measurement
 - ICP Measurement
 - Non-invasive ICP Measurement
 - IOP Measurement
- Existing Long-Duration Flight Occurrences
- Case Definition and Clinical Practice Guidelines
 - Classes
 - Stages
- Risk Factors and Recommendations
 - Immediate Actions
 - Near and Long Term Actions
- Benefits to Earth
- See also
- External links
- References

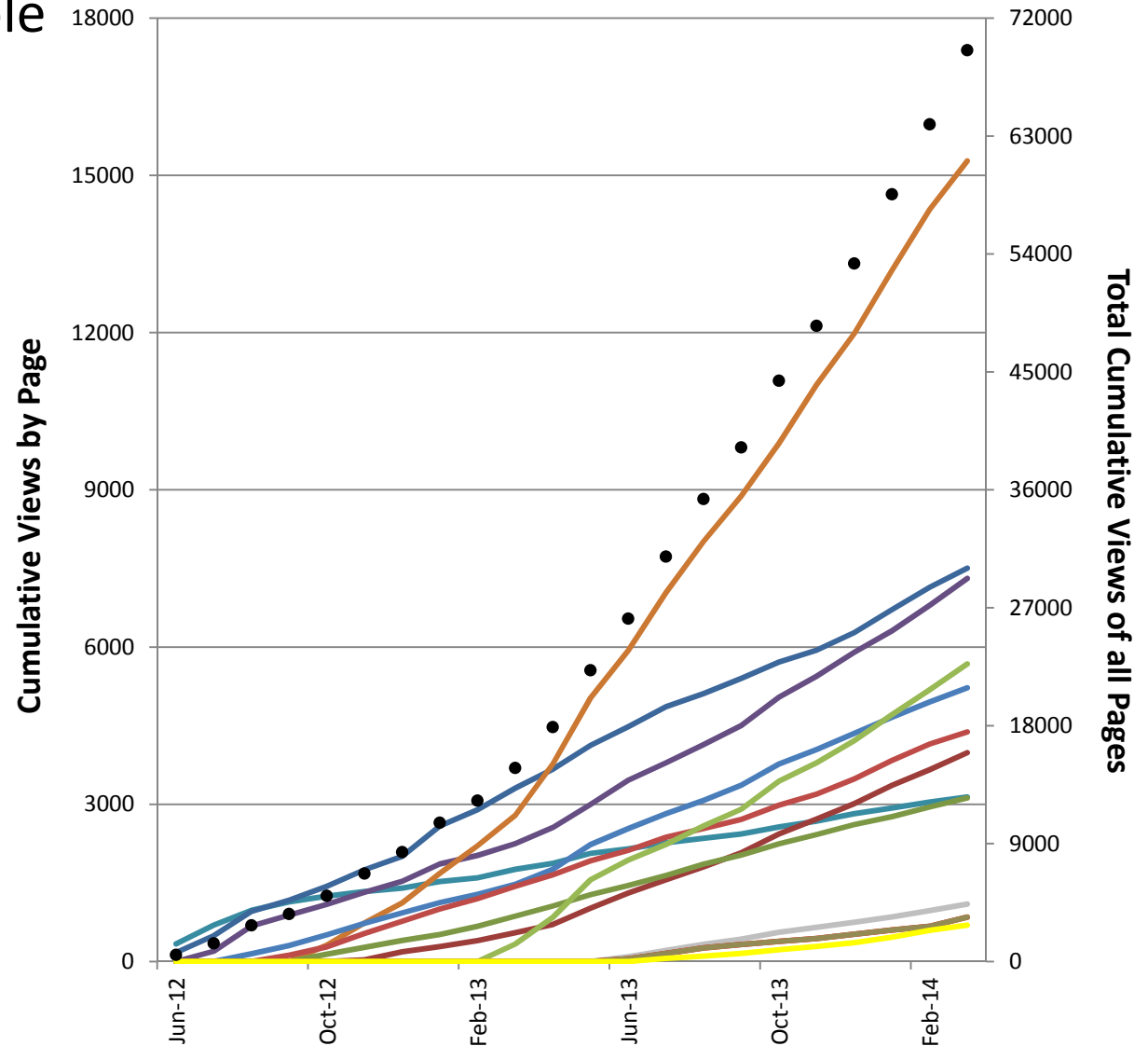
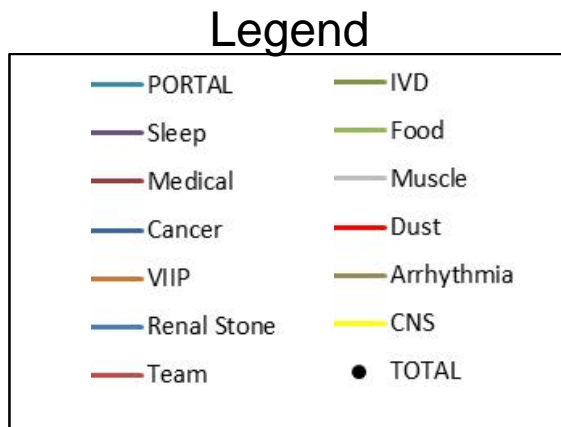


STS-41 crewmembers conduct Detailed Supplementary Objective (DSO) 472, Intraocular Pressure on the middeck of Discovery, Orbiter Vehicle (OV) 103. Mission Specialist (MS) William M. Shepherd rests his head on the stowed treadmill while Pilot Robert D. Cabana, holding Shepherd's eye open, prepares to measure Shepherd's intraocular pressure using a tono pen (in his right hand).

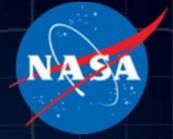
Strengths of the Wikipedia approach



- Extremely accessible
 - Reading
 - Contributing
- Many “hits”



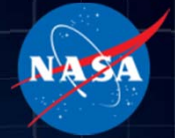
Weaknesses of the Wikipedia approach



- Wikipedia rules for content
 - Cannot copy Evidence Reports
 - Must summarize Evidence Reports
 - The resulting article is a summary of a review
- Few contributions
 - Net loss of content
 - Workload to maintain thriving articles is unknown

Metric	Number
Unique contributors	85
Total contributions	146
Minor contributions	80

The Third Generation Evidence Base



- Advantages

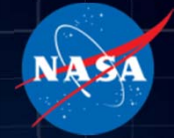
- Wiki-based
- Editorially controlled
- Verbatim copy of full Evidence Report

- Implementation plan

- Contributions will be added:
 - Directly by pre-approved contributors and
 - Indirectly by other individuals using an email link at the top of each Evidence Report page
- Each HRP Element will have an Editorial Board, which will review contributions before they are made publicly available

A screenshot of the NASA Human Research Wiki page for the "Exploration Medical Capability Evidence Report". The page features a navigation bar with tabs for "page", "discussion", and "history". Below the title, there are tabs for "TOC", "Intro", "Evidence Base", "Approach", "Risk", "Conditions", "Gaps", "Tasks & Deliverables", "Tech Watch", "Conclusion", and "Documents". A "Table of Contents" section lists sections I through XI, including Introduction, Evidence Base, Approach, Risk, Medical Conditions, Gaps, Tasks & Deliverables, Technology Watch, Conclusion, Applicable Documents, and Acknowledgements. A central image shows a collage of medical and space-related equipment. At the bottom, there is a link to "click here to view/download the PDF". The footer includes "Human Research Roadmap", "Privacy Policy & Important Notices", "Disclaimers", and a timestamp: "This page was last modified on 8 November 2013, at 14:50".

A Wiki entry



NASA Human Research Wiki

[page](#) [discussion](#) [history](#)

Risk of Adverse Behavioral Conditions and Psychiatric Disorders

For general comments, questions, and suggested edits regarding this page, please click [HERE](#) to send an email to the Editorial Board.

Content Pages

- [Main page](#)
- [Evidence Report](#)
- [Medical Conditions](#)
- [Gaps](#)
- [HRP Element Evidence Report](#)

Supporting Pages

- [Terminology](#)
- [What's New](#)
- [Help](#)
- [Editorial Policy](#)
- [Recent changes](#)
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Search

Toolbox

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- [2 Executive Summary](#)
- [3 Introduction](#)
- [4 Evidence](#)
- [5 Risk in Context of Exploration Mission Operational Scenarios](#)
- [6 Conclusion](#)
- [7 References](#)
- [8 Acknowledgments](#)
- [9 Appendix: Incidence of Physical and Behavioral Medical Events during Space Flight](#)

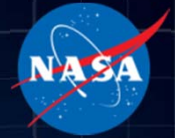
Risk of Adverse Behavioral Conditions and Psychiatric Disorders

Behavioral issues are inevitable among groups of people, no matter how well selected and trained. Spaceflight demands can heighten these issues. The Institute of Medicine [\[\[IOM\]\]](#) Safe Passage ^[1], notes that Earth analog studies show an incidence rate of behavioral problems ranging from 3-13 percent per person per year. The report transposes these figures to person crews on a 3-year mission to determine that there is a significant likelihood of behavioral conditions and psychiatric disorders emerging. Impacts of behavioral issues are minimized if they are identified and addressed early. The HRP must provide the best measures and tools to monitor and assess mood and to predict risk for an effective management of behavioral and psychiatric conditions prior, during and following spaceflight. ^[2]



An iconic photograph of Russian cosmonaut Valery Poliakov, who has clearly demonstrated his capacity for long-duration space flights, having completed two tours of duty on the Russian space station Mir, including one that lasted 438 days, thus setting a record that remains unbroken to this day. Current International Space Station missions involve crew stays of up to 6 months, with provision of an effective set of psychosocial countermeasures to aid crew morale and team cohesion.

Conclusion



- NASA's Human Research Program seeks to understand and mitigate risks to crew health and performance in exploration missions
- HRP's evidence base consists of an Evidence Report for each HRP risk
- Three generations of Evidence Reports
 - 1) Review articles
 - + Good content
 - Limited authorship, infrequent updates
 - 2) Wikipedia articles
 - + Viewed often, very open to contributions
 - Summary of reviews, very few contributions
 - 3) HRP-controlled wiki articles
 - + Incremental additions to review articles with editorial control
 - ?



humanresearchroadmap.nasa.gov/Evidence