A NASA Flight Surgeon Survey for Space Radiation Risk Communication

National Aeronautics and Space Administration

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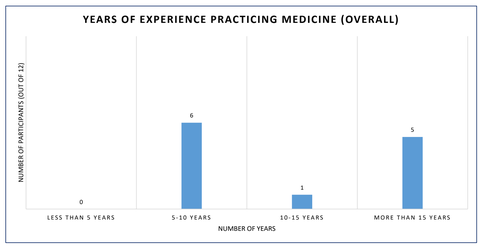
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Introduction

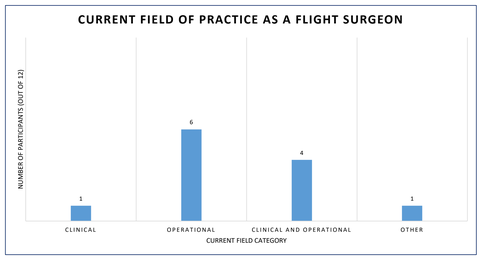
- The National Aeronautics and Space Administration (NASA) is planning towards future crewed missions to the lunar surface and beyond (e.g., Mars).
- Astronauts are exposed to various spaceflight hazards, including space radiation, which comprises a complex mixture of high linear-energy transfer (LET) particles.
- Crew members are expected to accumulate greater space radiation exposures than have been previously measured for missions beyond Low Earth Orbit (LEO).
- Tools that effectively communicate space radiation health risks are important for mission planning.
- NASA Flight Surgeons are tasked with communicating space radiation risks to crew members for flight certification and informed consent of spaceflight hazards.
- In keeping with recommendations of the National Academies of Sciences, Engineering, and Medicine1 (NASEM) [1], NASA is engaged in improving its risk communication tools.
- In an effort to improve these tools, NASA Flight Surgeons participated in a voluntary Cognitive Task Analysis (CTA) questionnaire that solicits information about the primary concerns of space radiation health risks and best approaches for risk communication.
- NASA's Multi-model Ensemble Risk Assessment (MERA) Project will combine the outputs of multiple predictive radiation risk models for the purposes of mission planning and communicating radiation risk information to astronauts.

Research Objective and Method

- The objective of this research was to solicit knowledge and information from NASA flight surgeon subject matter experts about the primary concerns of space radiation health risks and best approaches for risk communication.
- The goal is to improve communication, and thus understanding, regarding probabilistic Risk of Exposure Induced Death (REID) model projections and the underlying statistical assessments.
- The questionnaire was created with consideration of an Earth to Mars mission, with 400 days transit time and a 600 day stay on the Martian surface, and consisted of 11 main questions (accompanied by follow-up discussion based on participant responses).
- For this effort, the data collection methods were adapted from Robert R. Hoffman's "Protocols for Cognitive Task Analysis" [2]; a collection of methods that provide researchers the needed tools to understand how people think and perform under certain conditions.
- 12 total NASA Flight Surgeon participants (out of approximately 30+ in the flight surgeon cadre) volunteered for this effort after informed consent.
- Each flight surgeon participated in a one-on-one guided interview for an average of 1-hour via Microsoft Teams or in person at NASA's Johnson Space Center.

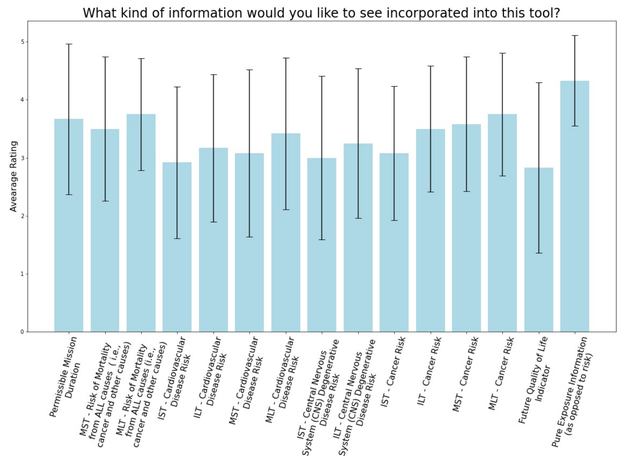


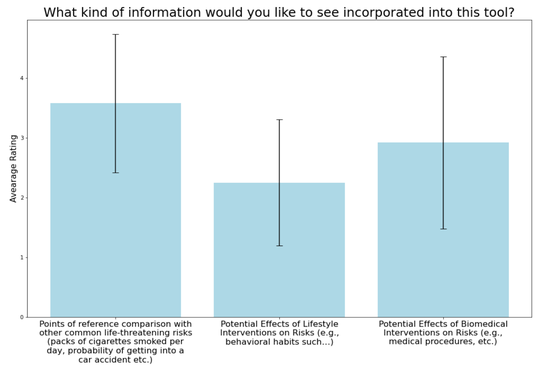
Areas of Specialization:
Aerospace Medicine
Emergency Medicine
Family Medicine
Internal Medicine
Occupational Medicine



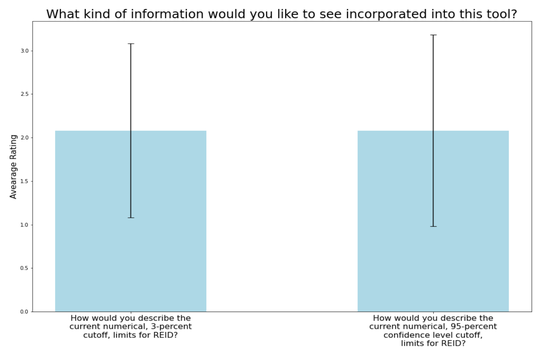
Research Findings

- Consensus among the majority of participants is that the current methods used for communicating radiation exposure risks for crewmember medical certification and assignment are sufficient for current missions to the International Space Station; however, updates will be needed for missions to Mars given the radiation environment for Mars is different than what is currently experienced by crew members.
- 10 out of 12 participants believed having a tool that takes into account, and communicates, additional measures of radiation exposure risks would be beneficial for future crew decisions and long-term care.
- Participants noted that having as much information as possible is important, but with the caveat that the data/source of information is reliable and "perfect."
- The use of analogies that are appropriate and representative of the astronaut crew to communicate space radiation risks was viewed as nice to have; however, some participants did note there may be some limitations given the innate uncertainty of those risks.
- The majority of participants (8 out of 12) chose "Mean" as the most important way of presenting statistically relevant data. 95% Confidence Level was the second most important as participants consider these as standards and the most relevant.
- Participants were more concerned with long-term outcome; however, some participants take both near-term and long-term into consideration. The credibility of evidence weighs heavily on their decision making.
- Credibility of evidence was also noted by participants if Space Permissible Exposure Limits (SPELs) are updated in the future, along with the need for additional training.
- Having a customizable visualization tool (along with new training on how to use and interpret the information) was important to participants.
- Other factors important to medical decision making included: Dose Rate, Genetics (legal implications), and Policy Maker Thresholds.





- The questionnaire was composed of a combination of Likert-scale questions, rank orders, and open-ended questions designed to identify key elements of risk information.
- Responses are subjective in nature and are based on participants' experience and exposure to radiation risk related topics. As such, the results are not weighted (by level of experience, etc.) as every response is taken into consideration.



Key Takeaways

Training — Current training is helpful and meets the needs of current missions to the International Space Station; however, additional training material will be needed to incorporate the unique challenges of going to Mars.

"Perfect Data" / **Credibility of Evidence** — Participants believed that having more information is better, but only if that information is "perfect." In other words, participants want to make sure the information and data they have is accurate and from credible and reliable sources.

Customizable Visualization Tool — Although participants believed that more information is better, they did not want to be overloaded with information all the time. They would prefer a tool that has plenty of information but is customizable to their needs and specific missions/astronauts. Visual data was also preferred over just pure numbers; however, they would like the option to have both.

Conclusion and On-going Research Efforts

- Overall, four major key takeaways were observed based on common themes and trends among the participants interviewed.
- A tool that can be customized based on Flight Surgeon needs was preferred with the added ability to customize based on specific mission and astronaut portfolio.
- Additional training (added to current training material) was considered important to account for the unique challenges of going to Mars. Training on the future customizable tool would also be needed.
- Credibility of evidence and having reliable information sources were considered crucial to decision making.
- A similar questionnaire has been developed to elicit knowledge and information from retired NASA astronauts concerning the same topics presented to the flight surgeons. This work is currently on-going.

References

[1] National Academies of Sciences, Engineering, and Medicine. 2021. Space Radiation and Astronaut Health: Managing and Communicating Cancer Risks. Washington, DC: The National Academies Press. https://doi.org/10.17226/26155

[2] Hoffman, R.R.: Protocols for Cognitive Task Analysis. Technical report, State of Florida Institute for Human and Machine Cognition (2005)

Acknowledgements

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