

Book Review

Shelhamer M, Antonsen E. *Systems Medicine for Human Spaceflight*.

Hackensack (NJ): World Scientific Publishing; 2024; 368 pgs; \$138;
ISBN: 978-981-12-8768-8. Available from <https://doi.org/10.1142/13713>.

This book, by two noted experts in National Aeronautics and Space Administration (NASA) human research and medical care, presents the current and future methods of medical care for long space missions outside of low Earth orbit (LEO). The publisher's description is accurate and conservative: <https://www.worldscientific.com/worldscibooks/10.1142/13713#t=aboutBook>.

LEO is the first of a daunting number of NASA acronyms that render reading of some concepts difficult. Using a systems approach, the authors cite current efforts and future predictions to safeguard the health of space explorers, with a clear view toward a Mars mission. Its organization is logical: context of spaceflight, current approaches, systems engineering and medicine, terrestrial models, and new approaches. The definition of systems medicine offered is from Wikipedia, "...an interdisciplinary field of study that looks at the systems of the human body as part of an integrated whole, incorporating biochemical, physiological, and environmental interactions." Absent from this definition is mention of the biopsychosocial paradigm in clinical care and minimal acknowledgment of national or local health care systems, e.g., the UK National Health Service or the U.S. Veterans Health Administration.

The first chapter is a useful review of NASA human habitat design and criteria: accommodate, use, and protect the human. Nonaeromedical readers will benefit from the description of life support systems, although lacking in detail.

Much of the material in subsequent chapters is descriptive and generic, e.g., medical kit preparation methods are described, but there are no specifics or examples from other risky concept domains. Also, some concepts—Markov analysis, KSAs (knowledge, skills, and abilities), etc.—are not defined. Some American informal usage will not be understood by foreign readers, e.g., "wicked problem." The current medical risk model is logical and probabilistic, but the title, Medical Extensible Dynamic Probabilistic Risk Assessment Tool (MEDPRAT), typifies the density of both the NASA names and the prose. There are some baffling, perhaps invented, words, such as "instantiation" in a

dense paragraph beginning "one can think of...HSIA...with the crew..."—60 words long. And there are longer!

The chapter on Systems-Based Primary Care is useful to nonphysicians, but oriented only to the United States. The author laments lack of time with each patient, but this assertion is not based on scientific study of outcomes. (This reviewer practiced primary care, and at one point scheduled 5-min appointments, but with same day "open access" for all.) Further, the concept of the "medical home" design of primary care is not mentioned, wherein all resources are in the same hallway in the clinic: physician, pharmacist, social worker, managing nurse, etc. Similarly, the concept of "n-of-one" experiment is incorrect. Studying one patient is an anecdote only. One author describes following a single elderly home-bound patient with various sensors, but fails to acknowledge his financial conflict of interest.

The chapter on legal risk in commercial spaceflight is worthy, but limited to the United States, and no author is identified as a lawyer.

Copious diagrams and flow charts illustrate the concepts, and the use of relationship diagrams is innovative and helpful. One author's use of Boyd's Observe Orient Decide Act (OODA) Loop was first derived for combat operations in the Vietnam War era, and there is probably no better descriptor, although "Plan Do Study Act" is more familiar. A discussion of machine learning models is useful, but artificial intelligence evolves almost daily.

This book's strengths are the experience and achievements of its authors and contributors and the descriptions of the current NASA methods. Its limitation is lack of editing for redundancy and, particularly, readability. It will appeal to students and professionals in space medicine who are interested in the longer Moon and Mars missions. Its price, \$138 USD, may be typical for small-volume academic books, but could be less, if multiple pages of references after each chapter were omitted. These references are only searchable via the e-book.

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