



UTILIZATION OF ARTIFICIAL INTELLIGENCE-BASED TOOLS TO SUPPORT AUTONOMOUS MEDICAL OPERATIONS

Human Research Program
Science Integration Office

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“Expanding the Boundaries of Space Medicine and Technology”



Disclosure Information

2025 AsMA-UHMS Annual Scientific Meeting

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

I have no relevant financial relationships to disclose.

Agenda



- **Background**
- **Objective**
- **Approach**
- **Challenges and Limitations**
- **Lessons Learned**

Background



*Risk is inherent in human spaceflight. However, specific risks can and should be understood, managed, and mitigated to reduce threats posed to astronauts.**

- **Risk Title:** Risk of Adverse Health Outcomes and Decrements in Performance due to Inflight Medical Conditions
- **Risk Statement:** Given that medical conditions will occur during human spaceflight missions, there is a possibility of adverse health outcomes & decrements in performance during these missions and for long term health.
- **What is required for the Medical Risk to be acceptable:** High confidence that astronauts can accomplish mission medical tasks in a progressively autonomous fashion (HSRB May 2021)

DRM Categories	Mission Type and Duration	Operations		Long-Term Health	
		LxC	Risk Disposition *	LxC	Risk Disposition *
Low Earth Orbit	Short (<30 days)	3x2	Accepted	3x2	Accepted
	Long (30 days-1 year)	4x2	Accepted	4x2	Accepted
Lunar Orbital	Short (<30 days)	4x2	Accepted	3x2	Accepted
	Long (30 days-1 year)	5x3	Requires Mitigation	4x2	Requires Characterization
Lunar Orbital + Surface	Short (<30 days)	4x3	Requires Characterization	4x2	Requires Characterization
	Long (30 days-1 year)	5x4	Requires Mitigation	4x4	Requires Characterization
Mars	Preparatory (<1 year)	5x4	Requires Mitigation	4x4	Requires Characterization
	Mars Planetary (730-1224 days)	5x5	Requires Mitigation	5x4	Requires Characterization

DRM = design reference mission

L x C = likelihood and consequence

*<https://www.nasa.gov/hhp/human-system-risks/>

Medical Risk Increases with Distance from Earth



International Space Station

Gateway

Lunar Surface

Mars Transit

CURRENT STATE

- 180-day to 360-day mission duration
- Strong consumables resupply
- Real-time communications
- Regular sample returns to Earth
- Emergency evacuations possible
- Relatively large internal volume
- Earth-reliant

EXPLORATION CLASS MISSION

- 650-day to > 900-day mission duration
- Zero consumables resupply
- No real-time communications + blackouts
- No sample returns to Earth
- No evacuations possible
- (Likely) much smaller internal volume
- Crew/vehicle-reliant

Objective



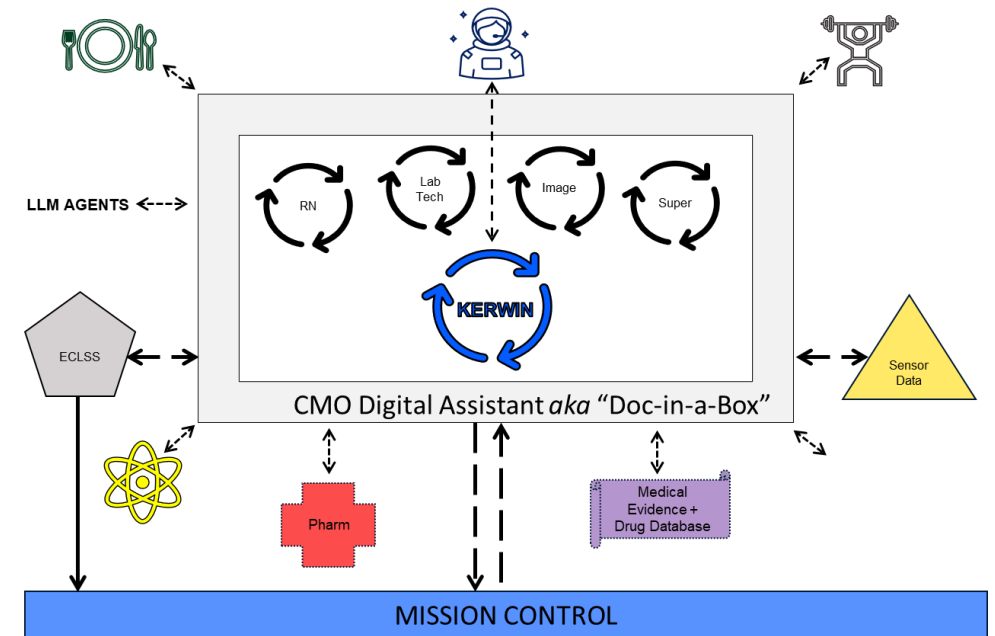
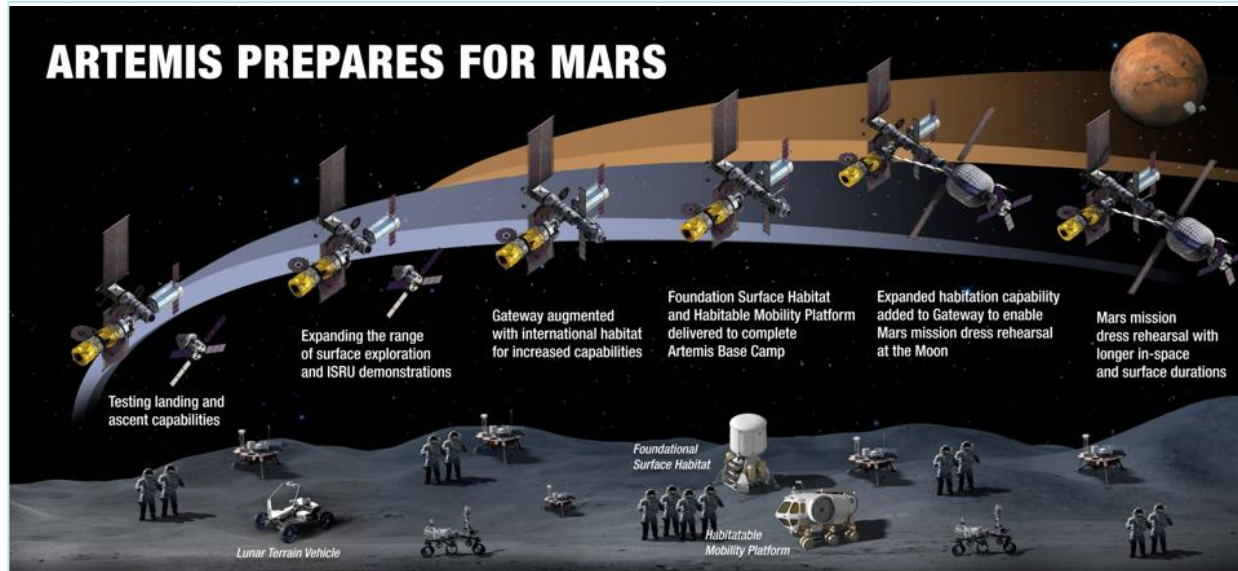
The Science Integration Office of NASA's Human Research Program (HRP) is **flexing the power and efficiency of artificial intelligence (AI) tools to reduce human system risk in space medicine operations.**

1. **“Doc-in-a-Box”**: Clinical Decision Support using an AI-powered digital assistant
2. **Objective Structured Clinical Examination (OSCE)**: Assessment of digital assistant performance
3. **AI-Assisted Evidence Collection**: AI-tool replicates development of Clinical Finding Forms (CliFFs)
4. **NASA's Human Research Program AI Strategy**: Develop methods & tools, deploy and iterate through pilot assessments
5. **Agentic Systems**: System of specialist agents embedded in a federated architecture

Approach

Artemis missions must lay the medical foundations for the first human mission to Mars

Iterative development, testing, validation & deployment of AI-based clinical decision support systems is critical



Challenges and Limitations



MCC + MER

- 80+ systems experts
- 660 years combined specific systems experience
- ~2 years to operator cert
- Additional years to specialist cert
- In-depth understanding of a single system
- Training builds academic engineering background
- Constantly using skills and studying flight rules

Astronauts

- 4 crew members
- 91 years combined relevant work experience
- 2 years ASCAN training
- ~ 2 years flight-assigned training
- *I&S, C&T, EPS, ETCS, ECLSS, ITCS, Emergency, MCS, OOM, Struc & Mech, Crew Systems, VV, Orb Mech, CMO, Med Ops, EVA, ROBO, Ops LAN, Photo/TV
- **Time Gap between training and flight; degradation of knowledge may be significant**

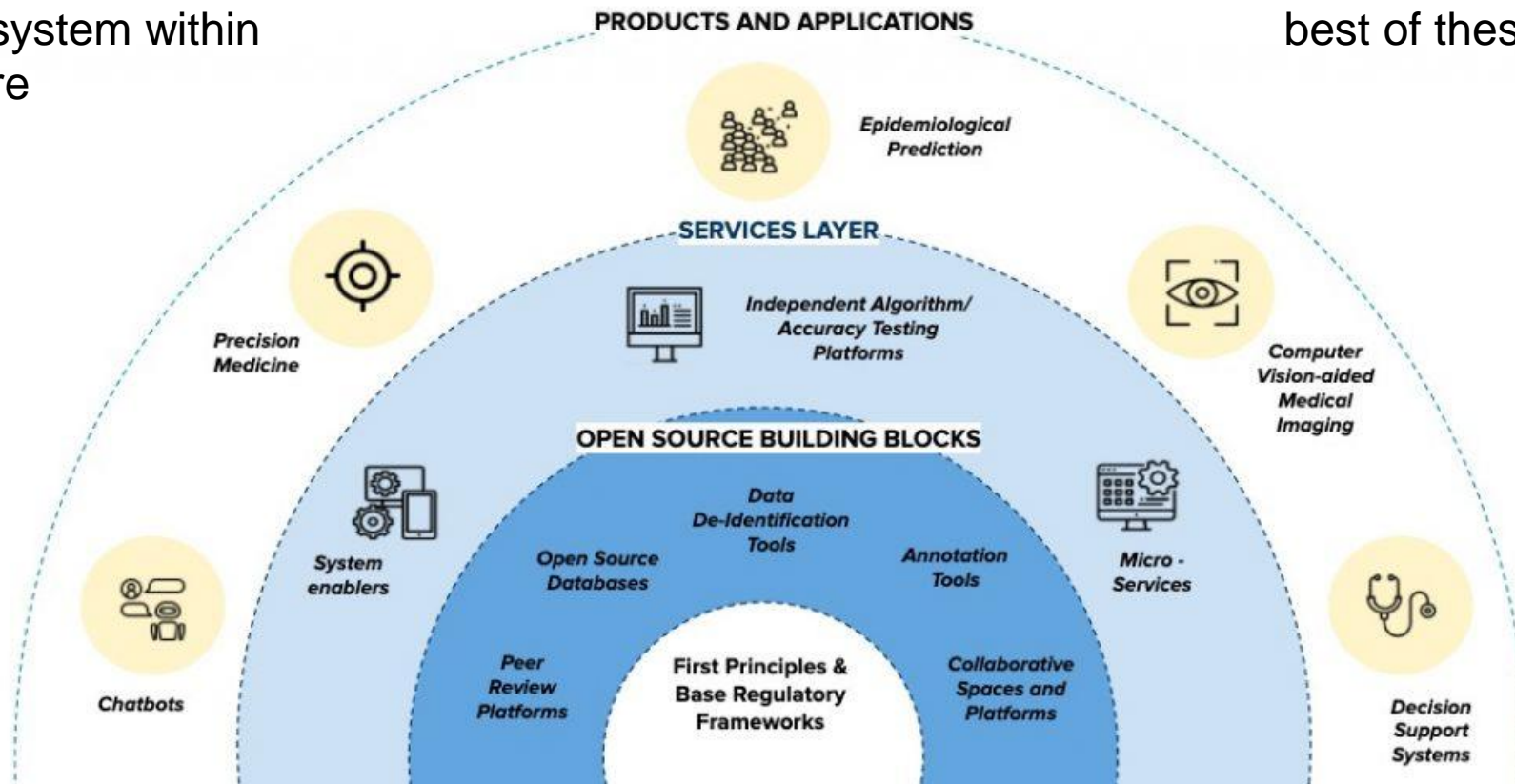
“4 people with 25 years experience each on 4 console positions cannot replace 10 people with 10 years of experience on 10 consoles positions even though both groups have 100 years total experience. It’s not just the experience, it’s the experience in unique console positions.”

Lessons Learned



- Terrestrial medicine has seen the emergence of a myriad of AI tools and emergence of a new ecosystem within healthcare

- Space medicine should test, validate and operationalize the best of these AI tools





Questions?

