



# Human Research Program Exploration Medical Capability

Presenter Name  
Presentation Date



# The Human Research Program



- NASA's Human Research Program (HRP) conducts and coordinates research projects that provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration.



*Clay Anderson centrifuges blood samples for a nutrition project during Increment 15*



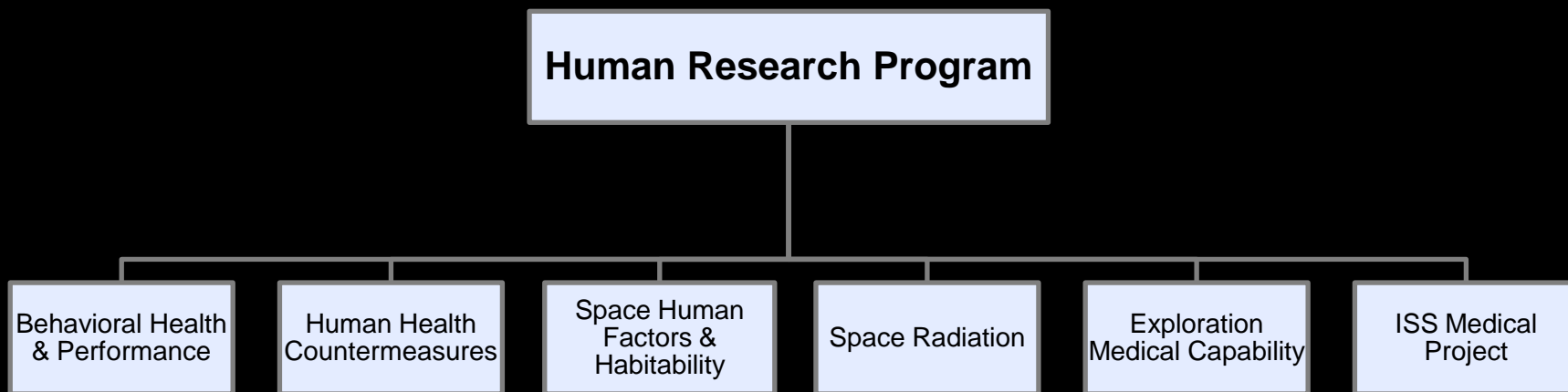
*Example of a study on the effects of center of gravity on performance*



*TJ Creamer next to the IntraVenous Fluid GENERation system after installation on ISS*



# HRP Organization & Elements



- The Program is divided into 6 major elements, which
  - Provide the Program's knowledge and capabilities to conduct research, addressing the human health and performance risks
  - Advance the readiness levels of technology and countermeasures to the point of transfer to the customer programs and organizations
- The National Space Biomedical Research Institute (NSBRI) is a partner with the HRP in developing a successful research program.



# HRP Participating Centers



## **Ames**

- Behavioral Health & Performance
- Exploration Medical Capability
- Human Health Countermeasures
- ISS Medical Project
- Space Human Factors & Habitability
- Space Radiation

## **Glenn**

- Exploration Medical Capability
- Human Health Countermeasures

## **HQ**

- Advocacy
- Int'l Agreements

## **Langley**

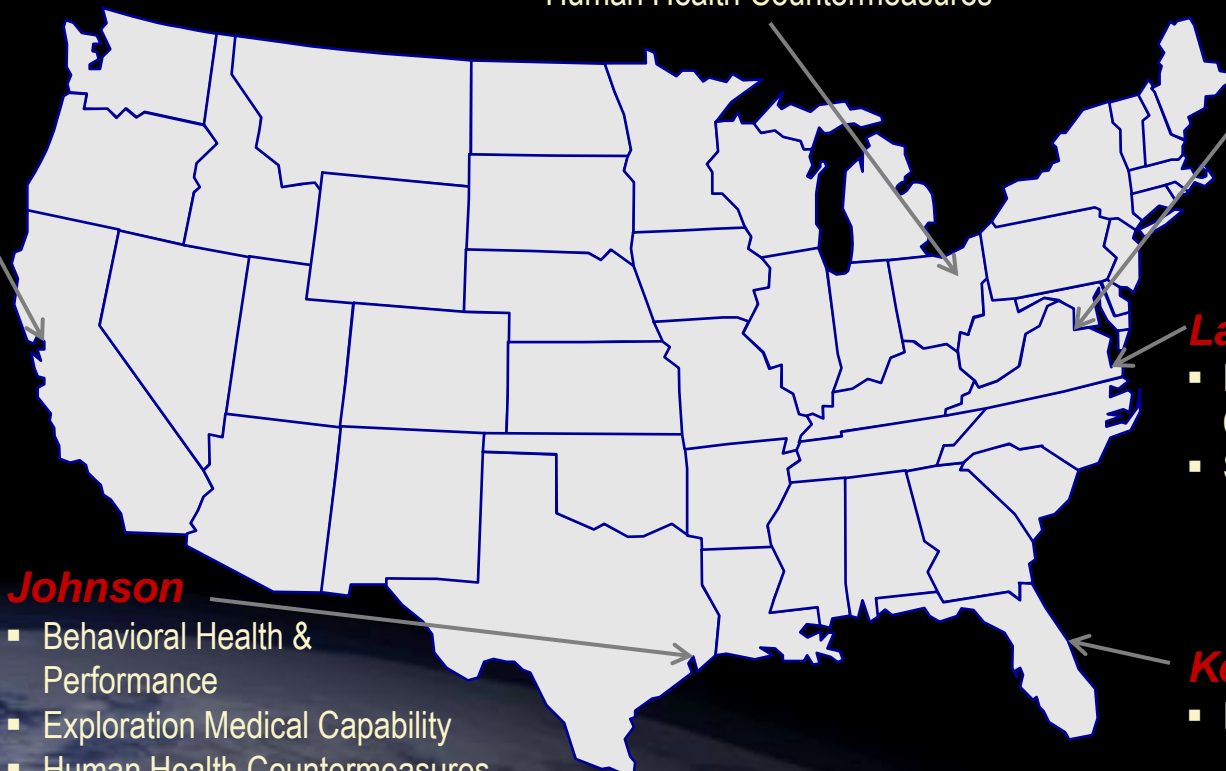
- Exploration Medical Capability
- Space Radiation

## **Johnson**

- Behavioral Health & Performance
- Exploration Medical Capability
- Human Health Countermeasures
- ISS Medical Project
- Space Human Factors & Habitability
- Space Radiation

## **Kennedy**

- ISS Medical Project





# The Exploration Medical Capability Element

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- The Exploration Medical Capability (ExMC) Element is charged with reducing the risk of the “inability to adequately recognize or treat an ill or injured crewmember” during an exploration mission.
- To reduce this risk, ExMC
  - Defines requirements for health maintenance
  - Develops treatment protocols
  - Extrapolates from the protocols to health management modalities
  - Evaluates the feasibility of these modalities
  - Develops technology and informatics that will enable the availability of medical care and decision systems
- ExMC utilizes ground, analog, and flight resources



# ExMC Organization & Projects



## Exploration Medical Capability

Element Manager: David Baumann

Element Scientist: Sharmi Watkins, MD, MPH

### Ames Research Center

(Moffett Field, CA)

Manager: Paul Fung

[Paul.Fung@NASA.gov](mailto:Paul.Fung@NASA.gov)

#### Projects:

*Biosensors*

*Life Sciences Data Archive*

*Exploration Lab Analysis*

*Technology Watch*

### Glenn Research Center

(Cleveland, OH)

Manager: DeVon Griffin, PhD

[DeVon.W.Griffin@NASA.gov](mailto:DeVon.W.Griffin@NASA.gov)

#### Projects:

*Biosensor Integration*

*Consumables Tracking*

*EVA Injectables*

*Imaging Integration*

*Integrated Medical Model*

*Intravenous Fluid Generation*

*Oxygen Concentrator*

*Reusable Lab Analysis*

### Johnson Space Center

(Houston, TX)

Manager: Jimmy Wu

[Jimmy.Wu@NASA.gov](mailto:Jimmy.Wu@NASA.gov)

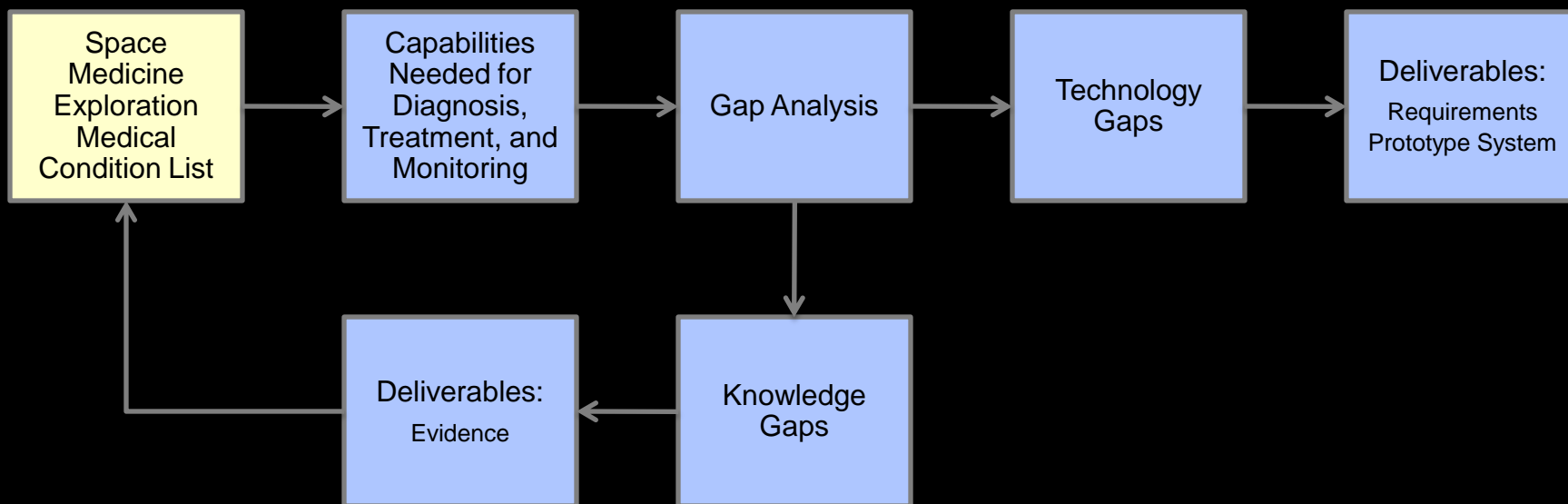
#### Projects:

*Integrated Medical Model*

*Life Sciences Data Archive*



# Risk Mitigation Approach





# Space Medicine Exploration Medical Condition List

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- To address the broad risk of “the inability to adequately recognize or treat an ill or injured crewmember,” the Element identified medical conditions of concern for exploration missions.
- The conditions were derived from several sources
  - International Space Station (ISS) Medical Checklist
  - Shuttle (STS) Medical Checklist
  - Longitudinal Study of Astronaut Health (LSAH) In-flight Medical Condition Occurrences
  - NASA Flight Surgeon Subject Matter Expertise



# Space Medicine Exploration Medical Condition List (cont.)

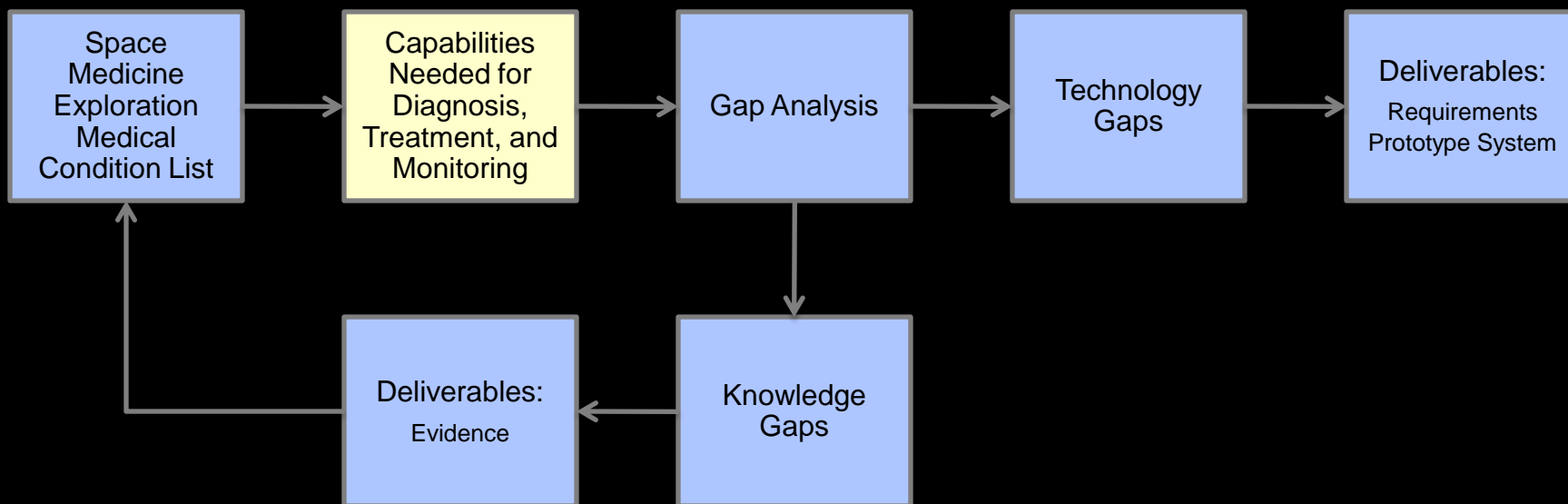
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- There are approximately eighty conditions on the medical condition list approved by NASA's Space Medicine Division in July 2009
- The conditions were prioritized by a panel of flight surgeons, physician astronauts, engineers, and scientists based on incidence, consequence, and mitigation capability
- The medical condition list is a “living document”
  - New conditions can be added to the list
  - The priority of conditions on the list can be adjusted as screening, diagnosis, or treatment capabilities change



# Risk Mitigation Approach





# Capabilities Needed for Diagnosis, Treatment, and Monitoring

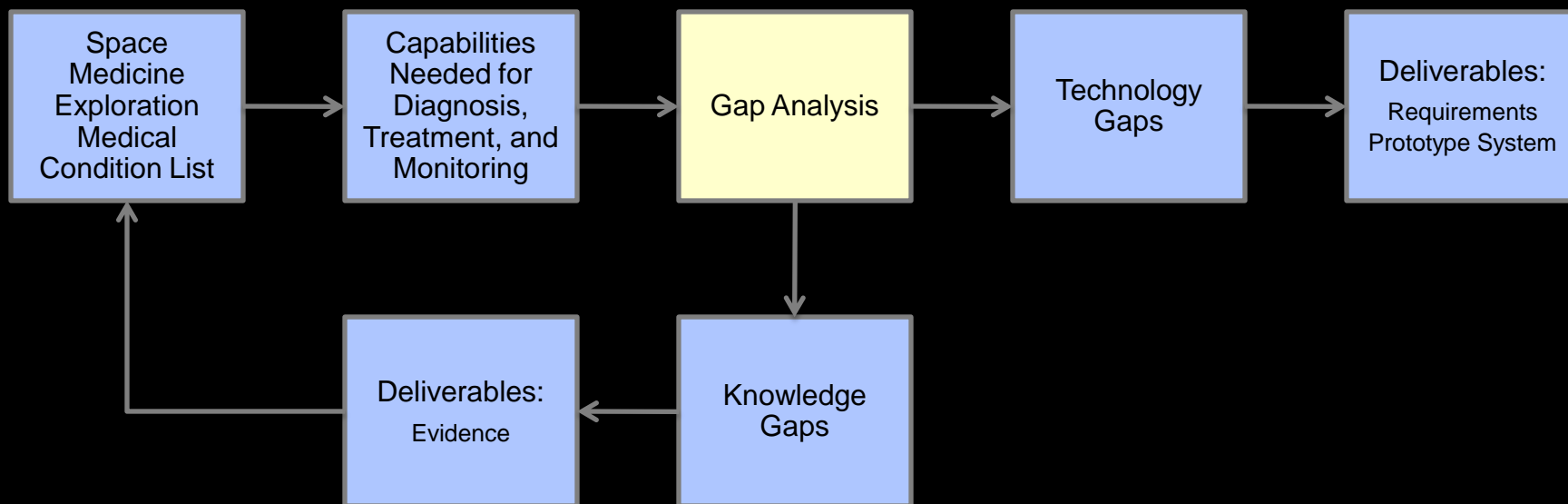
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- From the prioritized medical condition list, ExMC determined the capabilities needed to address the medical conditions of concern.
- Where such capabilities were not currently available, a gap was identified.
- ExMC identified gaps in the following areas
  - Validation of Medical Standards
  - Risk Quantification
  - Risk Mitigation
  - Monitoring and Treatment of Conditions of Concern
  - Enabling Capabilities
- The identified gaps were incorporated into the ExMC Research Plan.



# Risk Mitigation Approach





# Gap Analysis

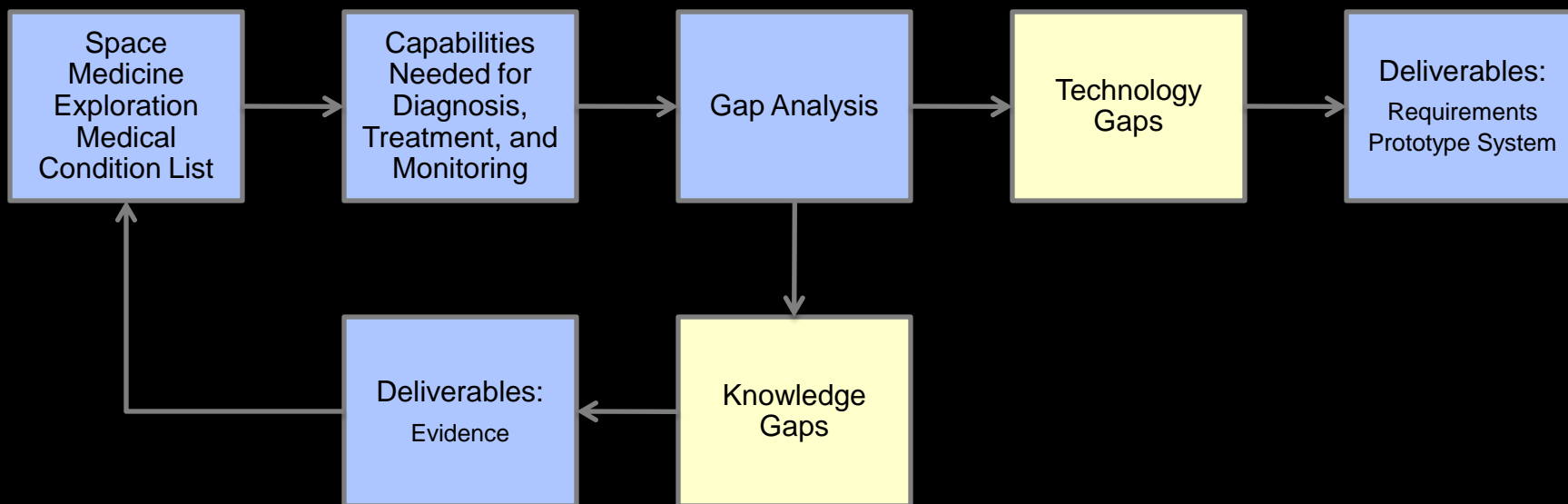
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- Analyses are conducted to determine if there is a need for technology or a need for knowledge to diagnose or treat each relevant condition on the medical condition list.
- Tasks and projects are assigned to address each technology or knowledge gap.
  - Technology gaps typically result in delivering requirements and/or a prototype system to the customer program for integration.
  - Knowledge gaps typically result in data or evidence gathered that updates the Space Medicine Exploration Medical Condition List in preparation for the next gap analysis.



# Risk Mitigation Approach





# Example Knowledge Gaps

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- ExMC 2.01: Lack of knowledge about incidence rates, probabilities, and consequence relative to Loss of Crew and/or Loss of Mission (LOC/LOM) for the medical conditions on the Exploration Medical Condition List
- ExMC 3.01: Lack of knowledge about effectiveness of current NASA medical training programs including crewmember and ground support in diagnosing and treating medical conditions to the best possible outcome
- ExMC 3.02: Lack of knowledge about the current state of the art in telementoring/telemedicine as a tool for assisting crewmembers to diagnose and treat medical conditions that occur in space flight



# Example Technology Gaps

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- ExMC 4.02: Lack of non-invasive diagnostic imaging capability and techniques to diagnose identified Exploration Medical Conditions involving internal body parts
- ExMC 4.05: Lack of minimally invasive in-flight laboratory capabilities with limited consumables required for diagnosing identified Exploration Medical Conditions
- ExMC 4.09: Lack of medical suction and fluid containment capability for chest tube and airway management
- ExMC 4.12: Lack of in situ intravenous (IV) fluid generation and resource optimization capability



# Technology Watch Overview

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- The objectives of the Technology Watch (Tech Watch) Process are
  - To identify emerging, high-impact technologies that augment current ExMC development efforts
  - To work with academia, industry, and other government agencies in order to accelerate the development of medical care and research capabilities for the mitigation of potential health issues that could occur during space exploration missions
- The establishment of partnerships with external organizations is beneficial to technology development and furthers NASA's goal to provide a safe and healthy environment for human exploration.



# Information Management

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- Each knowledge and technology gap is reviewed annually
  - Tech Watch Accomplishments
  - Tech Watch Plans
  - Contacts and Potential Collaborations for each Gap
  - Actions for each Gap
  - TRL Analysis for each Identified Technology
  - Technology Solicitation Recommendations for each Gap



# Areas of Interest

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- Novel medical screening technologies
- Delivery of medical training to non-clinicians
- Autonomous medical procedure systems
- Noninvasive diagnostic imaging
- Smart ventilators and oxygen concentrators
- Minimally invasive laboratory capabilities
- Stabilization and treatment of bone fractures
- Wound care and wound closure
- Rapid vascular access
- Advanced dental care
- Intravenous fluid generation



## Areas of Interest (cont.)

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- Inventory tracking for medications and other consumables
- Medication stability and shelf-life preservation
- Biomedical monitoring capabilities
- Medical data management systems
- Prevention and treatment of radiation sickness
- Medical suction and fluid containment capabilities
- Diagnosis and treatment of renal stones
- Delivery of medications to a suited crewmember
- Eye wash capabilities
- Auscultation in noisy environments



## Areas of Interest (cont.)

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- In-flight aerobic and strength training exercise systems
- Behavioral health and cognitive performance neurofeedback systems
- 3D virtual reality head-mounted display systems
- Wireless polysomnography systems

