ExMC Technology Watch

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2013 NASA Human Research Program Investigators’ Workshop
Technology Watch

• Objectives:
  – 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

• 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
Overview

• Background

• FY12 Highlights
  i. Gap reports
  ii. Gap report review process
  iii. Student/Capstone projects
Background - Overview

Technology Watch

Space Medicine Exploration Medical Condition List (SMEMCL)

Capabilities Needed for Diagnosis, Treatment, and Monitoring

Gap Analysis

Technology Gaps

Deliverables: Requirements Prototype System

Deliverables: Evidence

Knowledge Gaps

Tech Watch

Tech Watch
Tech Watch Organization

Exploration Medical Capability (ExMC) Element

**TECH WATCH**

Element Manager – Tammie McGrath
Deputy Element Manager – Bara Reyna
Element Scientist – Sharmi Watkins, MD
Deputy Element Scientist – Anil Menon, MD
Wiki Lead – Jack Rasbury
Technical Lead – Michael Krihak

Tech Watch Agent
**GRC**
Laurie Stauber

Tech Watch Agent
**LaRC**
Lisa Scott Carnell

Tech Watch Agent
**JSC**
Victor Hurst

Tech Watch Agent
**ARC**
Michael Krihak

Gap Owners
Gap 4.02 – B. Thompson
Gap 4.04 – S. Olson
Gap 4.06 – A. Weaver
Gap 4.09 – J. McQuillen
Gap 4.12 – J. McQuillen
Gap 4.14/4.15 – J. Zoldak
Gap 4.27 - TBD

Gap Owners
Gap 4.26 – L. Scott Carnell

Gap Owners
Gap 1.01/1.03 – R. Shah
Gap 2.01 – D. Butler
Gap 2.02, 4.24 – A. Menon
Gap 3.01, 4.01 – V. Hurst
Gap 4.03/4.08 – E. Kerstman
Gap 4.11 – M. Urbina
Gap 4.13, 4.22 – R. Shah
Gap 4.17 – D. Chin
Gap 5.01 – L. Best

Gap Owners
Gap 4.05 – M. Krihak
Gap 4.19 – A. Katterhagen
Gap 4.21 – A. Katterhagen
Gap 4.23 – M. Krihak
Gap Report Content (Public Domain)

• Each Gap Report contains:
  – Relevant medical conditions
  – Summary of evidence
    • Typically refers to prevention, diagnosis and treatment
  – References

• Gap reports reviewed annually
  – Structured, peer-reviewed process

• Gap reports are publicly available:
  http://humanresearchwiki.jsc.nasa.gov
  http://humanresearchwiki.jsc.nasa.gov/exmc (collaboration side)
Annual Revision Focus Areas:

- Gap title
- Update medical evidence
- Interim stages for gap closure and metrics (internal)
- Approach for gap closure (internal)
- Update present state of technology
- Target schedule for closure (internal)
- Update related Tech Watch summary
- Update related student work summary
- Schedule (internal)
Gap Report Review Process

Gap Owner – Report Update

Clinical & Technical Lead Review

Task Lead Review

SME Review

Element Manager Review

Element Scientist Review

ExMC Advisory Group Review (if necessary)

Gap Review Presentation to ExMC Team

Wiki Review, Post on Wiki

SME – Subject Matter Expert
Student Projects
FY12 Goal: Improve the efficiency of site visits

- Evaluate synergies through telecommunications first
  - Provide the point-of-contact with ExMC Gaps
- Determine whether or not a site visit is in the best interests
  - Obtain approval through Element management
- Identify appropriate personnel and laboratories to visit
- Provide a trip report to ExMC Tech Watch project
- *Develop targeted student project(s) that address specific gap needs*
Student Projects

Site visit
Student project
Tech Watch Accomplishments

General Highlights from FY12

• Joint-effort with HHC on an in-flight lab analysis capability
  – Findings through our Tech Watch process fed into the HHC development activity.
  – Several joint visits or telecons: DNA Medicine Institute, Nanomix, Rice University, OPKO, Philips, Biocartis

• Strategic collaborations/leveraging opportunities
  – Federal: DTRA, DARPA, Federal Laboratory Consortium
  – Private sector: IBM, GE
  – Research institutions:
    • Cleveland Clinic
    • Houston Technology Center (HTC) and Regional Centers of Innovation & Commercialization
    • Texas Medical Center’s National Center for Human Performance
General Highlights from FY12 (continued)

- Published Exploration Medical Capabilities agency tech need article in NASA Tech Briefs Magazine February 2012 issue
- Revisions of gap report and review process
- ExMC Gap brochure revision
- 15+ gap reports completed and available on the public wiki link:
  [http://humanresearchwiki.jsc.nasa.gov](http://humanresearchwiki.jsc.nasa.gov)
ExMGC Gap Brochure

Exploration Medical Capability Gaps

During long-duration exploration missions beyond low Earth orbit, the crew will need medical capabilities to diagnose and treat diseases as well as for maintaining their health. The Exploration Medical Capability Gap Brochure identifies medical technologies, medical informatics, and clinical capabilities for different levels of care during space missions.

Ensuring the health, safety, and effective performance of astronauts is critical to the human exploration of space. NASA Glenn Research Center’s Human Research Program (HRP) plays a vital role in providing solutions to critical problems that place human exploration missions and their crews at risk. Glenn’s efforts are accomplished in support of the Johnson Space Center, which leads NASA’s HRP.

NASA is looking for Federal laboratory, academic, or industry partners to collaborate with them on the HRP Exploration Medical Capability Gaps.

Any technology addressing these needs must be compatible with general space flight restrictions on mass, volume, electric ionizing radiation, and electromagnetic interference.

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Exploration Medical Capability Gaps — Areas To Be Investigated

1.01 Inadequate information on preflight medical screening capabilities for exploration class missions

1.02 Inadequate information on the individual susceptibility to hypoxic environments (e.g., 7.2 psi lunar habitat) (CLOSED)

2.01 We do not know the quantified mission and crew health consequences due to medical events for exploration class missions

2.02 We do not know the quantified crew health and mission impacts of including a physician crew medical officer on exploration missions

3.01 We do not know the optimal training methods for in-flight medical conditions identified on the Space Medicine Exploration Medical Condition List taking into account the crew medical officer’s clinical background

3.02 Lack of knowledge about the current state of the art in heterogeneous medical devices as a tool for assessing crewmembers to diagnose and treat medical conditions that occur in space flight (CLOSED)

3.03 Inadequate knowledge on capabilities for in-flight screening and diagnosis of conditions on the Space Medicine Exploration Medical Condition List

4.01 Lack of guided medical procedure system that integrates with medical hardware

4.02 Limited noninvasive diagnostic imaging capability and techniques to diagnose conditions on the Space Medicine Exploration Medical Condition List

4.03 Limited capability to treat bone/muscle pain and injuries in the space flight environment

4.04 We do not know what technologies can be used to provide supplemental oxygen to crewmembers from onset of illness through landing and recovery and also minimize the local oxygen buildup to avoid increasing the risk of fire

4.05 Lack of minimally invasive in-flight laboratory capabilities with limited consumables required for diagnosing identified Exploration Medical Conditions

4.06 Limited capability to stabilize and treat bone fractures

4.07 Limited wound care capability to improve healing following wound closure

4.08 Limited capability to treat muscle, ligament, and tendon injuries

4.09 Lack of medical suction and fluid containment capability for crew and body management in partial gravity and microgravity environments

4.10 Lack of rapid vascular access capability for space flight (CLOSED)

4.11 Limited dental care capabilities

4.12 Lack of intraosseous (IO) fluid generation and administration capability

4.13 Lack of capability to diagnose and treat a renal stone during an exploration mission

4.14 Lack of efficient medical inventory tracking system that provides data on overall usage and usage rate and integrates securely with vehicle inventory management system

4.15 Lack of medication usage tracking system that includes automatic time stamping and crew identification

4.16 Lack of technique or procedure to draw injectable medication into a syringe without bubble formation or bubble removal prior to medication delivery (CLOSED)

4.17 Lack of adequate protection for medications to preserve stability and shelf life in exploration class missions

4.18 Limited biomed and loading capabilities for in-flight activities such as periodic clinical status evaluations and contingency medical monitoring

4.19 Lack of a system to manage medical data collected from the patient in space flight that integrates with ground operations (MERGED WITH ExMGC 5.01)

4.21 Lack of eye wash capability to treat chemical exposure in partial gravity and microgravity environments

4.22 Limited capability to diagnose and treat radiation sickness

4.23 Limited capability to associate internal sounds of the body in a noisy space flight environment

4.24 Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments

4.25 Lack of capability to deliver medication to a crewmember in a pressurized suit

4.26 Limited capability to diagnose and treat pulmonary or systemic disease due to non-skeletal dust exposure

4.27 Limited capability to sterilize medical equipment in space flight

4.28 Lack of end-to-end medical data management infrastructure for exploration class missions
Student Project Highlights from FY12

- 20+ student projects
  - Topic area examples: chemical eye wash, assisted medical procedures, auscultation, laboratory analysis
  - Contributions to element: provided assistance in gap closure, ground analog testing protocols, collation of information/data for gaps, engineering design
  - Significant academic contributions:
    - Texas A&M, U. Michigan, UCLA, Johns Hopkins University

- Participated in 2012 RASC-AL (Revolutionary Aerospace Systems Concepts – Academic Linkage)
  - Concepts for nanoprobes developed by Washington University
Summary

• Exploration Medical Capability (ExMC) is charged with reducing the “Risk of Unacceptable Health and Mission Outcomes Due to Limitations of In-Flight Medical Capabilities”
  – The ExMC charter is to utilize technologies and informatics that address evidence-based medical conditions.

• Tech Watch was active in developing strategic collaborations with academia, federal laboratories and the private sector.

• Multiple senior projects were developed to address many of the ExMC technology and knowledge gaps.

• Tech Watch is continually improving internal capability to maintain database and track technologies.