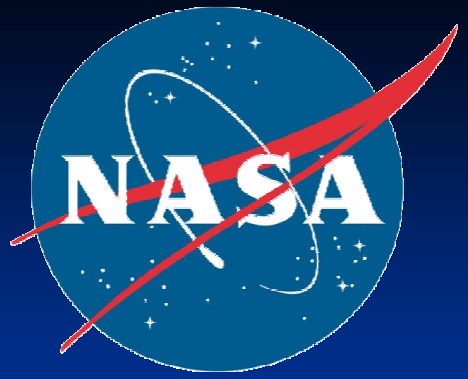

NASA Biomedical Informatics Capabilities & Needs

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Medical Informatics & Healthcare Systems Branch

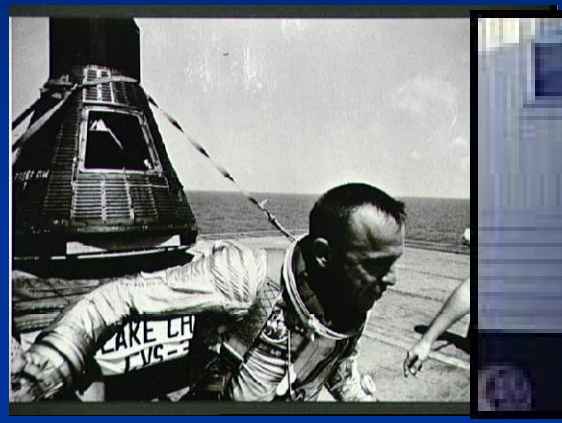
Medical Informatics & Healthcare Systems Branch

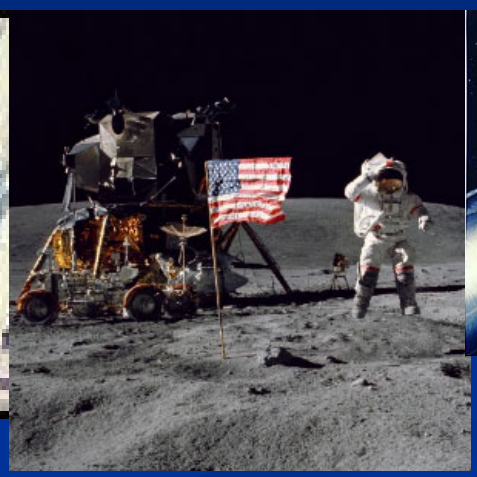
- Mission Statement
  - To improve on-orbit clinical capabilities by developing and providing operational support for intelligent, robust, reliable, and secure, enterprise-wide and comprehensive healthcare and biomedical informatics systems with increasing levels of autonomy, for use on Earth, low Earth orbit & exploration class missions.
- Biomedical Informatics
  - Biomedical Informatics is an emerging discipline that has been defined as the study, invention, and implementation of structures and algorithms to improve communication, understanding and management of medical information.
  - The end objective of biomedical informatics is the coalescing of data, knowledge, and the tools necessary to apply that data and knowledge in the decision-making process, at the time and place that a decision needs to be made

Biomedical Informatics @ NASA

- Evidence Base Collection and Coding
- Evidence Base Analysis
- Clinical Decision Support Systems
- Other Decision Support
- Data Visualization
- Data/Information/Knowledge Search and Retrieval

Evidence Base = 50 Years of Spaceflight Data





What Data Does NASA Have?

Life Science Data Archive (LSDA)

- Contains *research data* from NASA-funded experiments, primarily data from flight experiments and ground analog data collected at NASA facilities
- http://lsda.jsc.nasa.gov

Longitudinal Study of Astronaut Health (LSAH)

- Contains electronic health records (*medical data*) of all astronauts, including mission data
- Data are collected for clinical purposes
- Clinical data are analyzed by LSAH epidemiologists to identify trends in crew health and implement changes in pre-, in-, or post-flight medical care

Evidence Base Collection & Coding

- Capabilities:
  - Ease of data collection
    - Integrated with standard operations
    - Electronic Medical Record for clinical
    - Sharepoint Repository for additional info
  - Enablers for data analysis
    - Standardized terminologies: SNOMED & MESH
    - Structured data entry
    - Centralized data repository
- Challenges:
  - Predict metadata, ease of structured/coded data entry, more automated encoding

Evidence Base Analysis

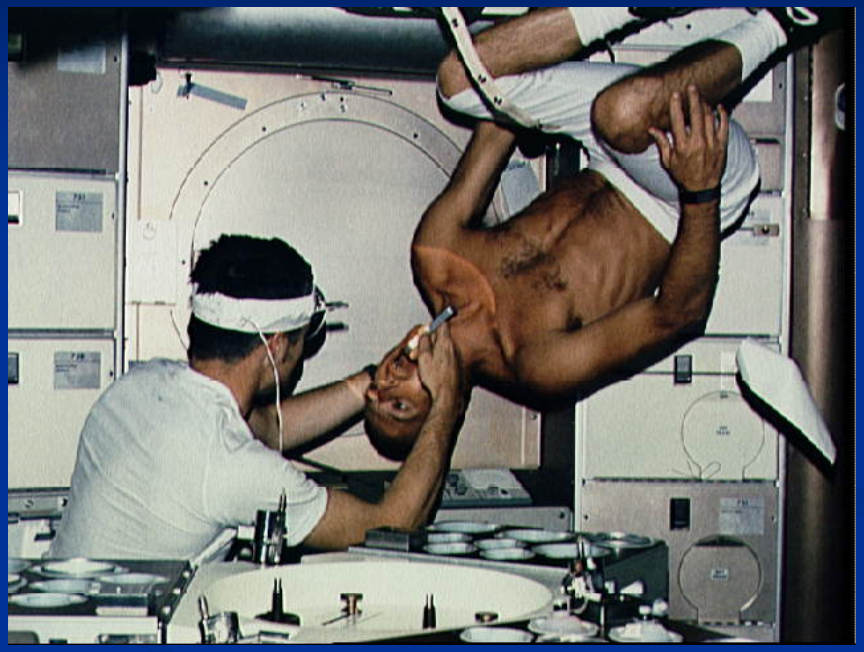
- Capabilities:
  - Team of epidemiologists
  - SAS software and JMP visualization tools
- Challenges
  - Small “n” especially for long duration missions
  - Comparability of data elements
    - Tests and collection techniques have changed over the years
  - Datasets to use for comparison
    - Analog population identification – subjects are healthier than average

Clinical Decision Support

- Capabilities
  - Ground
    - Through modules in EMR
  - Flight – Flight Surgeon
    - EMR support
    - Issue tracking in Sharepoint
  - Flight – Astronaut Crewmember
    - Data Collection programs, remote guidance from ground

Inflight Clinical Decision Support Challenges

- Training of the personnel providing medical care on board the space craft
  - Even if a physician is on board, what would happen if that person were ill or injured?



- Limited size and capability of the medical kit
- Time delay in communication with ground support personnel
  - Up to 45 minutes round trip to Mars

Exploration Class
Medical Decision Support Systems Goals

- On-board medical decision support systems can mitigate some of the challenges
- Functions:
  - Just-in-time training (generate the skill set as needed)
  - Refresher medical training (keep the skill set available)

Exploration Class Medical Decision Support Systems

- Functions:
  - Guided procedure execution
  - Automatic generation of status reports for ground personnel for both nominal and contingency situations
  - Consumables tracking
  - Medical monitoring for trends

Medical Decision Support Systems Keys to Success

- Ability to update the on-board procedures from the ground for the specific conditions and medical events as they occur in non-emergency scenarios.
- Integration of all aspects of the system – data, HW, human

Non-clinical Decision Support

- Support for requirements generation
- Capability = Integrated Medical Model (IMM)

IMM Project Goals

- To develop an integrated, quantified, evidence-based decision support tool useful to crew health and mission planners
- To help align science, technology, and operational activities intended to optimize crew health, safety, and mission success

Scope and Approach

IMM addresses in-flight risk only, and uses ISS data as stepping stone

- Scope
  - Forecast medical outcomes for in-flight operations only
  - Forecast medical impacts to mission
  - Does not assess long-term or chronic post-mission medical consequences
- Approach
  - Use ISS data as stepping stone to Exploration Program
  - Employ best-evidence clinical research methods
  - Employ Probability Risk Assessment (PRA) techniques
  - Collaborate with other NASA Centers and Organizations

What is IMM?

- A software-based decision support tool
  - Forecasts the impact of medical events on space flight missions
  - Optimizes the medical system within the constraints of the space flight environment during simulations.

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Who can benefit from IMM capabilities?

- Flight Surgeons
  - What in-flight medical threats are greatest for reference mission A?
- Risk Managers
  - What is the risk of evacuation - due to a medical event - for a 6-person, 180 day mission assuming the current in-flight medical capability?
- Vehicle Designers
  - What's the optimum medical mass allocation for given level of risk?
- Health Care System Designers
  - What medical items do we fly for a given mass/volume allocation?
- Trainers
  - How do I prioritize limited crew training hours?
- Requirement Managers
  - What's the rationale for this crew health requirement?

"What if…?" Questions

IMM is designed to help answer ***specific in-flight questions***

Questions

- Is the current ISS medical kit adequate for a crew of 6 on a 6-month mission?
- Does a 33-day lunar sortie mission require a different Level of Care than a 24-day lunar sortie mission?
- Are we carrying enough Ibuprofen for a crew of six on a 12-month mission?
- How does risk change if the ventilator fails at the start of a 3-year mission?

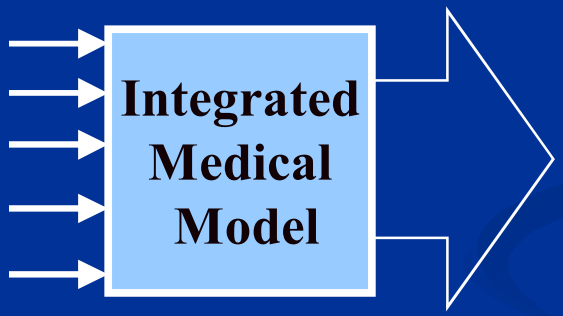
Questions

- What is the probability of a bone fracture occurring 10-years **after** a 6-month mission?
- What is the probability of renal stone formation **after** a 12-month mission?

IMM Conceptual Model

INPUTS

- Medical Conditions & Incidence Data
- Crew Profile
- Mission Profile & Constraints
- Potential Crew Impairments
- Potential Mission End states
- In-flight Medical Resources



OUTPUTS

- Medical Condition Occurrences
- Crew Impairments
- Clinical End States
- Mission End States
- Resource Utilization
- Optimized Medical System

Data Visualization

- Current capability:
  - Graphs and other display mechanisms pre-determined
- Challenges:
  - Dynamic generation of data visualization materials to support real-time problem solving

Search and Retrieval of Data/Information/Knowledge

- Capabilities:
  - Data/Information/Knowledge captured in many formats/applications – e.g. EMR, Sharepoint, file shares, etc.
  - Pilot project for a concept based search tool
- Challenges:
  - Searching across many collections of information
  - Finding relevant information easily

Summary

- Biomedical Informatics at NASA encompasses a broad range of activities
  - Clinical – data collection & analysis
  - Clinical decision support for ground and flight
  - Non-clinical decision support for requirements generation and assessment
  - Data visualization
  - Search & Retrieval of Data/Information/Knowledge