

Medical risks during the journey to Mars and its benefits on Earth

Baylor College of Medicine Emmanuel Urquieta, M.D., M.S. Senior Research Portfolio Manager NASA funded Translational Research Institute for Space Health

TRANSLATIONAL RESEARCH INSTITUTE FOR SPACE HEALTH



Low Earth Orbit (LEO)

All sizes to scale



Now Using the International Space Station

2020s Operating in the Lunar Vicinity (proving ground)

After 2030 Leaving the Earth-Moon System and Reaching Mars Orbit

Phase 0

Continue research and testing on ISS to solve exploration challenges. Evaluate potential for lunar resources. Develop standards.

Phase 1

Begin missions in cislunar space. Build Deep Space Gateway. Initiate assembly of Deep Space Transport.

Phase 2

Complete Deep Space Transport and conduct yearlong Mars simulation mission.

Phases 3 and 4

Begin sustained crew expeditions to Martian system and surface of Mars.

Example Phase 3 Mission Elements





Compare Going to Mars to Where We Are Today with ISS



228,000,000 kilometers ~1 - 3 years transit time Communications (up to 42 minutes) ~ 2 days transit time recreate living on Earth capability " Communications (near real-time) 390 kilometers Crew exchanges Crew supplies and logistics Crew and atmosphere samples Modified hardware extreme car camping in space Emergency Crew Return Trash





Orbital ATK | Dulles, VA

Boeing | Houston, TX

HRP Integrated Path to Risk Reduction PPBE19 Baseline



Mars Flyby		FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
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Autonomous Clinical Care



Crew Health Care Facility

non-invasive diagnostic capabilities for medical/surgical care

"smart" systems

non-invasive imaging systems

 definitive surgical therapy including robotic surgical assist devices and surgical simulators

blood replacement therapy

laboratory support

Telemedicine

- preventive health care
- diagnostic/therapeutic capabilities from groundbased consultants

Mars Surface Stay Requirements

Autonomous facilities

Crew health care

- Radiation Protection
- Medical Surgical care
- Nutrition Food Supply
- Psychological support
 meaningful work
 surface science
 - planetary
 - biomedical
 - simulations of Mars launch, trans-Earth injection, and contingencies
 - progressive debriefs, sample
 - processing, etc.
 - housekeeping
 - communications capability



Habitat

- Maintenance/housekeeping
 - workshop with HRET capabilities
- Exercise supplemental to Mars surface activities
- Recreation
- Privacy

Rodent Research Contributes to Osteoporosis Treatments



Ames Research Center

Amgen Inc. Thousand Oaks, California

NASA Technology

- NASA needs to learn how to protect bone density and muscle strength in astronauts while in space
- The Commercial Biomedical Testing Module (CBMT) developed at Ames houses mice for experimentation in microgravity to study the problem

Technology Transfer

- Amgen, through BioServe Space Technologies, arranged to test three treatments for maintaining bone health and density on mice aboard space shuttles
- Experiments traveled aboard missions in 2001, 2007, and 2011, yielding promising results



- One of the three treatments is now available as Prolia, an osteoporosis treatment, and a second is in clinical trials
- Prolia is shown to increase bone density and significantly reduce risk of bone fractures

Pressure Garments Save New Mothers' Lives



Ames Research Center

Safe Motherhood San Francisco, California

NASA Technology

- G-suits are worn by aviators and astronauts to prevent pooling of blood in lower body during extreme acceleration and reentry from orbit
- NASA discovered that similar compression garments can be used to treat women who experience severe bleeding after giving birth

Technology Transfer

- In the 1990s, the company ZOEX utilized NASA's research to develop the Non-Inflatable Anti-Shock Garment
- Later, an obstetrics professor designed a similar garment, the Non-Pneumatic Anti-Shock Garment (NASG), to stabilize women suffering from post-natal bleeding until they can receive medical care



- The NASG is backed by the World Health Organization and used in 20 countries.
- Mortality rate among women suffering obstetric hemorrhaging reduced by 50 percent in studies conducted in Egypt, Nigeria
- Garment can be used at least 70 times, which comes out to less than a dollar per application.

Tool Kit Simplifies Development of High-Affinity Molecules



Johnson Space Center

AM Biotechnologies LLC Houston, Texas

NASA Technology

- NASA will need new diagnostic capabilities to monitor astronauts' health as they travel to Mars
- Antibodies, commonly used to detect biomarkers, degrade when exposed to radiation and are only viable for a few months

Technology Transfer

- Short strands of DNA and RNA can fold themselves into three-dimensional structures called aptamers, which can be used for diagnostics, are impervious to radiation, and don't degrade
- After securing an SBIR contract, AM Biotechnologies developed a new method to rapidly create precise diagnostic aptamers using micro-beads that aptamers stick to



- X-Aptamer Selection Kit, already being used by universities and industry, takes days, not weeks, to create the desired aptamers
- X-Aptamers could be used to target drug treatments for cancer, other diseases
- One aptamer, Pegaptanib, approved by the FDA as a treatment for macular degeneration

Space-Ready Spectrometer Offers Terrestrial Advantages



Jet Propulsion Laboratory

Brimrose Corporation Sparks, Maryland

NASA Technology

- In the 1990s, NASA was looking for a rugged spectrometer for a lander to be carried by the European Space Agency's Rosetta comet orbiter
- Chemical composition analysis was to be conducted by spectroscopy in the near-infrared and visible light spectra

Partnership

- Brimrose secured two SBIR contracts to make a space-ready acousto-optic tunable filter (AOTF) spectrometer, but NASA pulled out of the lander project
- Spectrometer made to be lightweight, energyefficient, and able to withstand extreme temperatures and radiation exposure



- Brimorse's Luminar AOTF analyzers now widely used by pharmaceutical industry, agriculture, healthcare, material science, oil companies
- New versions include touchscreens, longer battery life, and Linux compatibility
- Company uses AOTF in other applications, including acousto-optic modulator flown on ISS

Access to the Deep Space Network for the vehicle may be as limited as 1 hour in a 24 hour period.



A Mars mission cannot use the current operational medical approach because that approach is totally dependent on real-time communication with the ground.

Spaceflight Associated Neuro Ocular Syndrome (SANS)

SANS case definition:

• Diagnosis: Papilledema Frisen grade 1 o more through fundoscopy.





Self-Imaging, Wide Angle, High Resolution Retinal Imaging System



Bob Main, ABOM SeeCare Technologies LLC





 Helps to obtain lymphatic flow images

What it does

Software will be able to estimate flow

- New technology using a NIRF (infrared) camera
- Why it's cutting edge
- Uses minimal amounts of injected dye
- FDA approved

Lymphatic Imaging Device Eva Sevick, Ph.D. U.T. Health Sciences

How it can be used

Could help to explain what causes SANS (Spaceflight Associated Neuro-Ocular Syndrome)



Contact

- emmanuel.f.urquietaordonez@nasa.gov
- emmanuel.urquieta@bcm.edu