

# Protecting the Health of Astronauts

Enhancing occupational health monitoring and surveillance for former NASA astronauts to understand long-term outcomes of spaceflight-related exposures

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# Potential Terrestrial and Spaceflight Exposures Among Astronauts

Spaceflight Exposures



Pre-NASA Exposures

ASCAN Training

Active Astronaut

Retirement



Terrestrial Exposures



# Physiological and Psychosocial Manifestations Associated with Spaceflight

## Bone

- ↓ Bone mineral content
- ↓ Bone mineral density
- ↑ Urinary calcium
- ↑ Renal stone risk

## Skeletal Muscle

- ↓ Skeletal muscle mass
- ↓ Skeletal muscle strength
- ↓ Skeletal muscle endurance
- ↓ Skeletal muscle capillary density

## Neurosensory

- ↑ Vestibular disturbances
- ↑ Space motion sickness
- ↓ Sensorimotor function
- ↓ Postural & locomotor stability

## GI/Pharmacokinetics

- ↓ GI motility and PK



## Cardiovascular

- ↓ Fluid volume
- ↓ Orthostatic tolerance
- ↓ Aerobic capacity
- ↑ Arrhythmias

## Psychosocial

- ↑ Team issues
- ↑ Confinement issues
  - ↑ Fatigue
  - ↑ Stress
  - ↑ Errors
- ↓ Cognitive Function

## Environmental

- ↑ Hearing loss due to acoustics
- ↑ Radiation exposure
- ↑ Risk of cataracts/cancers
- ↑ Skin irritations due to microbial growths



# Expanded Medical Monitoring of Retired Astronauts

- Upon retirement from active status, astronauts may voluntarily return to the JSC Flight Medicine Clinic for an annual preventive exam, which includes selected screening tests.
  - ❖ ~65% of retirees returned for an annual exam in 2016
  - ❖ ~88% of retirees returned for an annual exam at least once in last three years
- NASA has proposed expanding retiree medical monitoring to
  - ❖ Leverage and build on existing US Preventive Health Services Task Force recommendations (e.g., colonoscopy, mammography, testing more frequently and/or at younger ages)
  - ❖ Include occupational monitoring for conditions thought to be related to spaceflight (e.g. Triennial DXA scans for males and females, ocular ultrasound for long duration flyers)
- Expanding the selection of medical monitoring tests for retired astronauts is a critical opportunity to
  - ❖ Better characterize conditions resulting from astronaut occupational exposures
  - ❖ Rule out conditions resulting from the natural aging process of astronauts
- **As astronauts age, and as mission durations increase, we need to better understand the long-term impacts of spaceflight.**



# Current and Potential Monitoring Tests for Former Astronauts, by System/Risk

| System/Risk       | Current Monitoring Tests                                | Potential Additional Monitoring Tests |
|-------------------|---------------------------------------------------------|---------------------------------------|
| Behavioral Health |                                                         | Behavioral/Cognitive Assessment       |
| Bone              | DXA                                                     |                                       |
|                   | Serum bone turnover markers                             |                                       |
| Cancer            |                                                         | Mammography                           |
|                   |                                                         | Colonoscopy                           |
| Cardio-pulmonary  | Vital Signs (heart rate, blood pressure, height/weight) | Calcium Score CT Exam                 |
|                   | Resting ECG                                             |                                       |
|                   | Fitness evaluation (if requested by crewmember)         |                                       |
|                   | Pulmonary Function Test                                 |                                       |
| Dermatology       | JSC Clinic screening                                    | External specialist screening         |
| Hearing           | Auditory testing                                        |                                       |

| System/Risk | Current Monitoring Tests                                                                                                                                                    | Potential Additional Monitoring Tests                                                                                                           |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Vision/VIIP | Visual Acuity                                                                                                                                                               | Visual fields                                                                                                                                   |
|             | Intraocular Pressure                                                                                                                                                        | Ocular ultrasound                                                                                                                               |
|             | Lens Opacity Classification                                                                                                                                                 |                                                                                                                                                 |
|             | Ocular Coherence Tomography (OCT)                                                                                                                                           |                                                                                                                                                 |
|             | Fundus Exam                                                                                                                                                                 |                                                                                                                                                 |
| Laboratory  | CBC w/ Differential<br>Electrolytes & Chemistry<br>Additional blood values:<br>Lipids, Thyroid, Iron,<br>Magnesium, Uric Acid,<br>Vitamin D, HbA1C,<br>hs-CRP<br>Urinalysis |                                                                                                                                                 |
| Other       |                                                                                                                                                                             | As clinically indicated based on individual NASA occupational exposure history (e.g., cadmium, renal ultrasound, spinal evaluation/CT, eye MRI) |



# Completed Work

- NASA has begun an extensive exploration of expanding medical monitoring services for former astronauts under the Astronaut Occupational Health program, including
  - ❖ Review of the program's overall approach
  - ❖ Consideration of policy implications
  - ❖ Development of an algorithm to estimate cost of expanding medical monitoring services
    - based on historical astronaut data and knowledge of existing retiree population
    - cost of mammography, colonoscopy, dermatologic screening, CAC score testing
    - cost of secondary testing on proportion of population
    - travel costs
- NASA strengthened existing process for baselining medical monitoring requirements for active and former astronauts
  - ❖ Multiple approval boards assessing medical importance and resource determination for a given monitoring test
  - ❖ Input from aerospace medicine experts
  - ❖ Documentation of standard practice

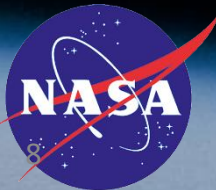


# Forward Work

- Continue support of Astronaut Occupational Health legislation currently moving through US Congress which could facilitate
  - ❖ Expansion of medical monitoring services
  - ❖ Addition of treatment and compensation services
- Broaden scope of algorithm to integrate other operational costs not previously evaluated
- Continue to develop the evidence base of occupational health risks to astronauts



Thank You





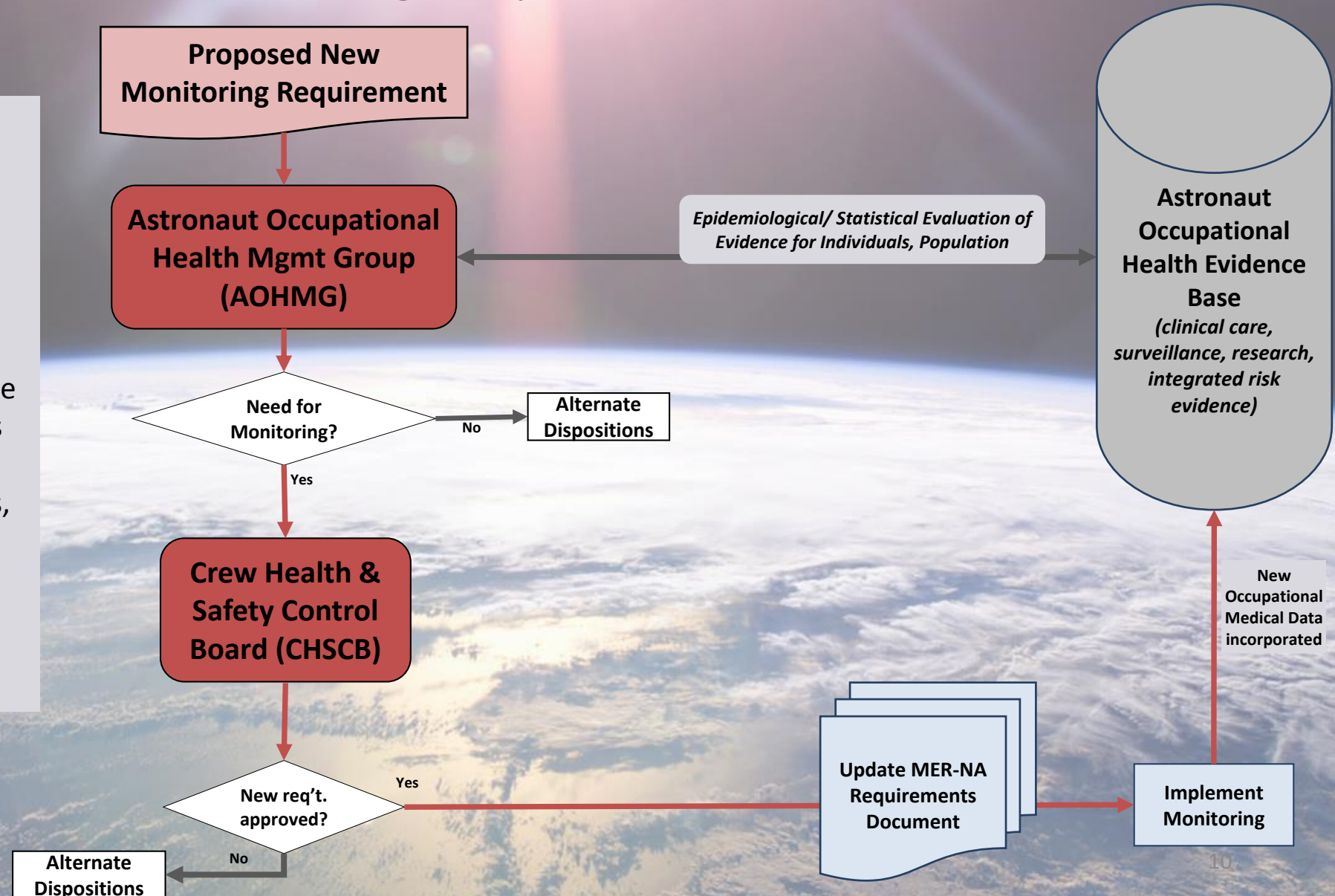
A wide-angle photograph of Earth from space. The sun is positioned at the top center, creating a bright lens flare that illuminates the scene. The Earth's horizon is visible as a thin blue line. Below the horizon, the planet's surface is covered in a dense layer of white clouds. The word "BACKUP" is centered in the middle of the image in a bold, black, sans-serif font.

**BACKUP**



# Existing NASA Change Management Process for Baseline Monitoring Requirements

- Expanding the current state of medical monitoring is possible through existing processes for review, approval, and funding (CHS, AOHMG, PPBE process).
- Monitoring and surveillance to be conducted for former astronauts would be discussed and determined through this process, and documented in the Medical Evaluation Requirements – Non-active Astronauts (MER-NA).





# Components of the Astronaut Occupational Health program

## Monitoring

The adoption, provision, and management of medical screening tests for an individual Astronaut to provide evidence for conditions suspected to be associated with the Astronaut occupation and to rule out association with healthy Astronaut aging.

## Treatment

The management of reimbursement for treatment of an individual Astronaut with a condition determined to be associated with the Astronaut occupation whose reimbursement claim is approved via a systematic process.

## Compensation

The management of disability determination and settlement provision to an individual Astronaut with a condition determined to be associated with the Astronaut occupation whose reimbursement claim is approved via a systematic process.