Unique opportunities when you're a Military and NASA flight surgeon

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ISS Exp 52/53, 60/61 Crew Surgeon

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Unique Opportunities for Military Medical Providers

- **Consider**
  - Challenging, changing career
  - Extreme environments
  - The people you meet
  - Overall purpose

Challenging, changing career

Extreme Environments

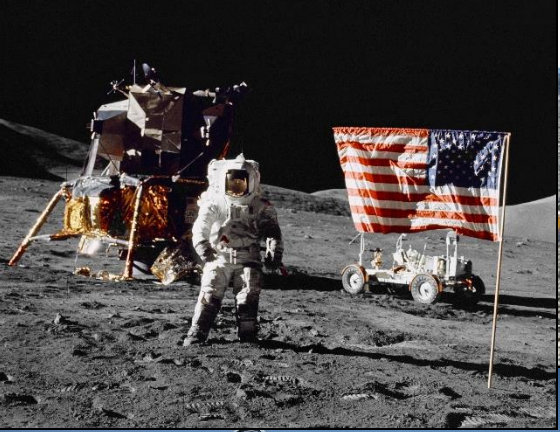
Can Transition From Calm …

To Chaos in minutes

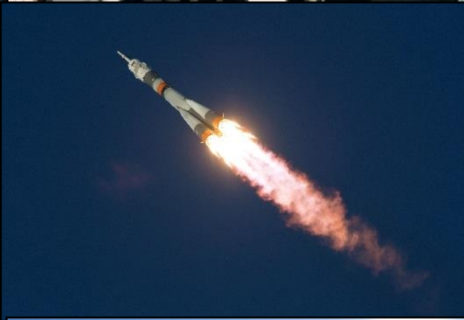
Small town family practice/sports medicine doc in rural Illinois

then 9/11/2001…

Free travel anywhere in the world…













Apollo, Space Shuttle, and ISS
Launch/Landing Support

Space Medicine

- One Definition:

  Space medicine combines many medical specialties to examine the effects of spaceflight on humans and prevent and treat problems associated with living in the unique, isolated, and extreme environment of space.
  In other words, you get paid to think

Star Trek, The Original Series, Paramount Television, 1968

NASA FS Roles & Responsibilities

- **Critical mission tasks**
  - Medical certification of astronauts for training and missions
  - Medical care of astronauts and their families
  - Support during medical consultations
  - Military astronaut selection exams
- **Operational mission tasks**
  - Medical support for space missions
  - Oversight of crew and flight controller medical training
  - Medical support to crew members prior to launch
  - Monitoring EVAs
  - Participation in contingency/rescue management during launch and landing
  - Being part of the flight control team in the mission command center

NASA JSC Flight Surgeon Duties

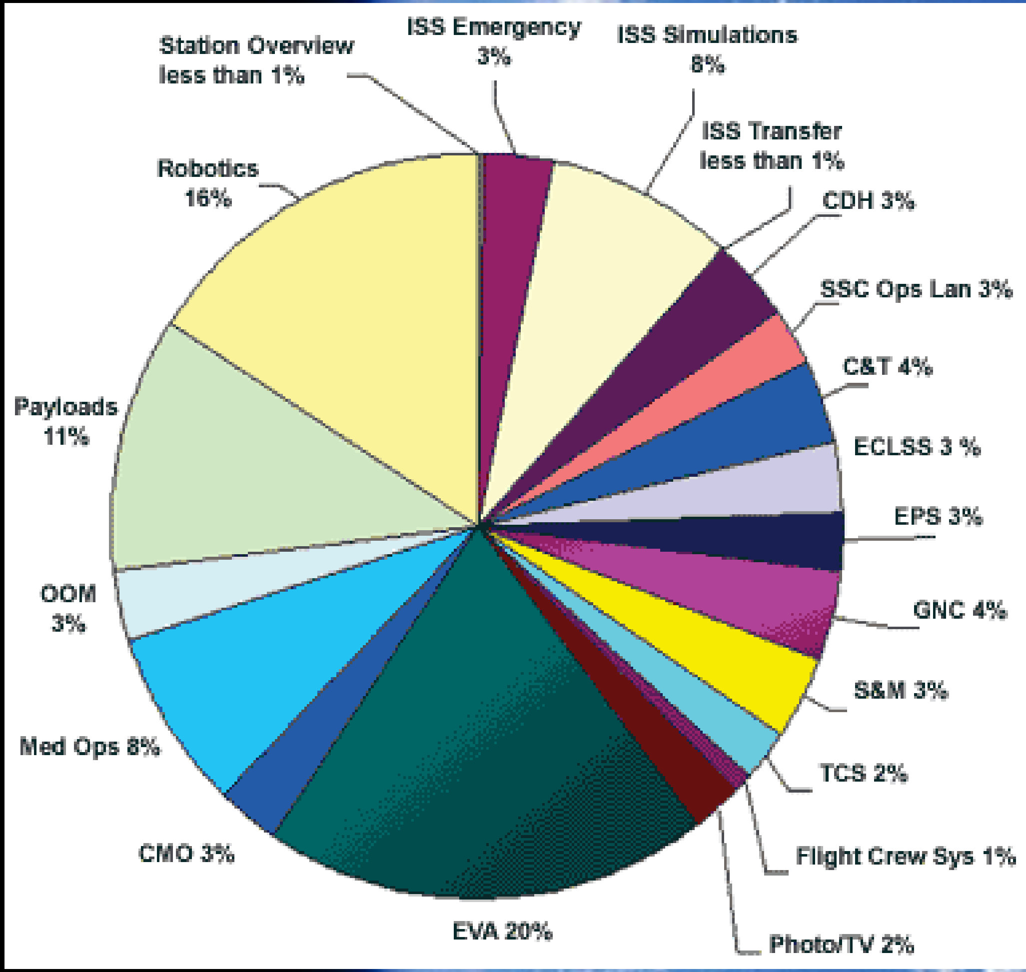
- Aircraft Operations Directorate (AOD)
  - Perform all pilot, engineer annual flight physicals, aeromedical summaries, and occupational medical intervention
  - Provide medical input as part of a mishap investigation team
  - Fly with aircrew as MO
  - Provide medical recommendations for aircraft h/w, policies and procedures
  - Medical support of the Reduced Gravity Office ("vomit comet")

NASA JSC Flight Surgeon Duties

- Research
  - Serve as medical monitor for all astronaut research protocols
  - Independently supports clinical and operational research studies involved in space medicine
  - Supports exploration space mission effort with medical device technology development

Integrated team

ISS Crew Pre-flight Training

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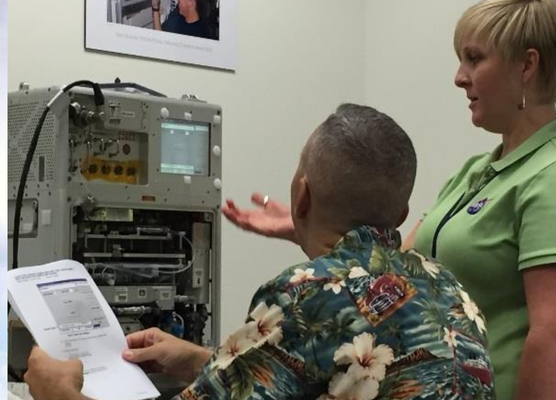

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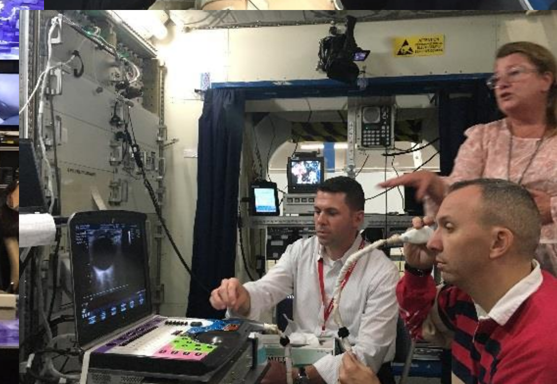


63
NASA
64
NASA

ISS Crew On-Orbit Support

The Integrated Medical System (US and Russian) covers three basic concerns:

1) Physiological countermeasures to adverse spaceflight impacts
2) Environmental monitoring and countermeasures
3) Medical monitoring and countermeasures

Physiological effects of Short- and Long Duration Space Flight on the Human Body

- Space Motion Sickness (SMS)
- Neurovestibular
- Cardiovascular
- Musculoskeletal
- Immune/Hematopoietic system
- Gynecological
- Behavioral/Psycho-social

STS-132 May, 2010

Medical Care in Space

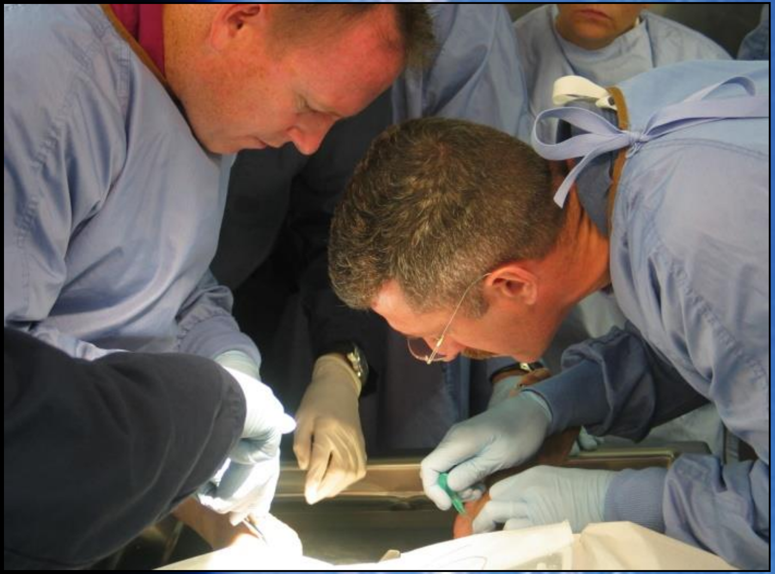
Although human physiology is altered by exposure, particularly long term exposure, to microgravity, basic metabolic and physiologic processes remain largely unchanged

Vs.

As a result, medicine can be practiced along the same general lines as on earth, with many of the same devices.

Medical Care in Space

- Crew Medical Officer (CMO)
  - Limited training
  - Air-to-ground communication limits
  - Limited resources
- MCC Flight surgeon
  - Limited time to “work the problem”
  - Requires evidence-based resources within arms reach



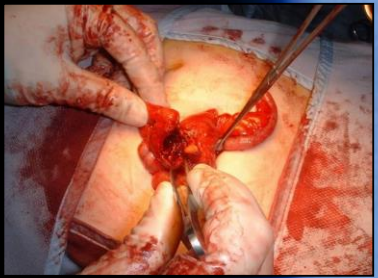
Medical Care in Space

-Focus is **prevention of illness, infection, pain**

-Can support life threatening emergency, to some degree

-Medical care is provided by the Crew Health Care System (CHeCS) for the ISS

-Surgeon is responsible for training the Crew Medical Officers (CMO) – two per crew



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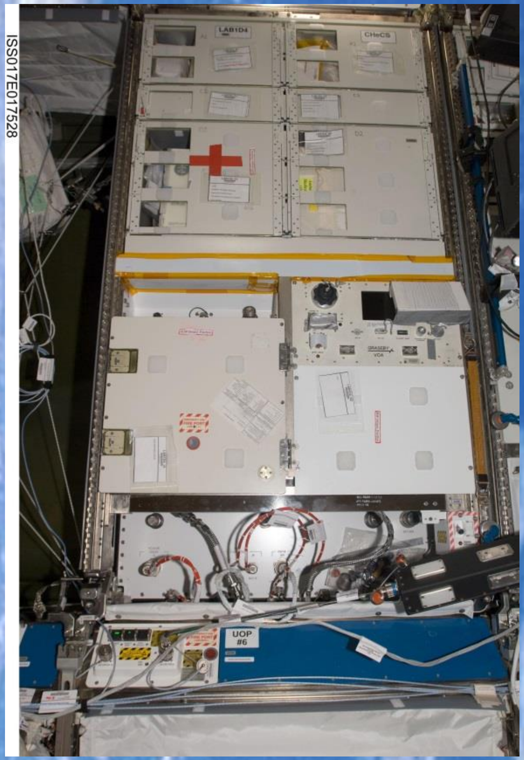
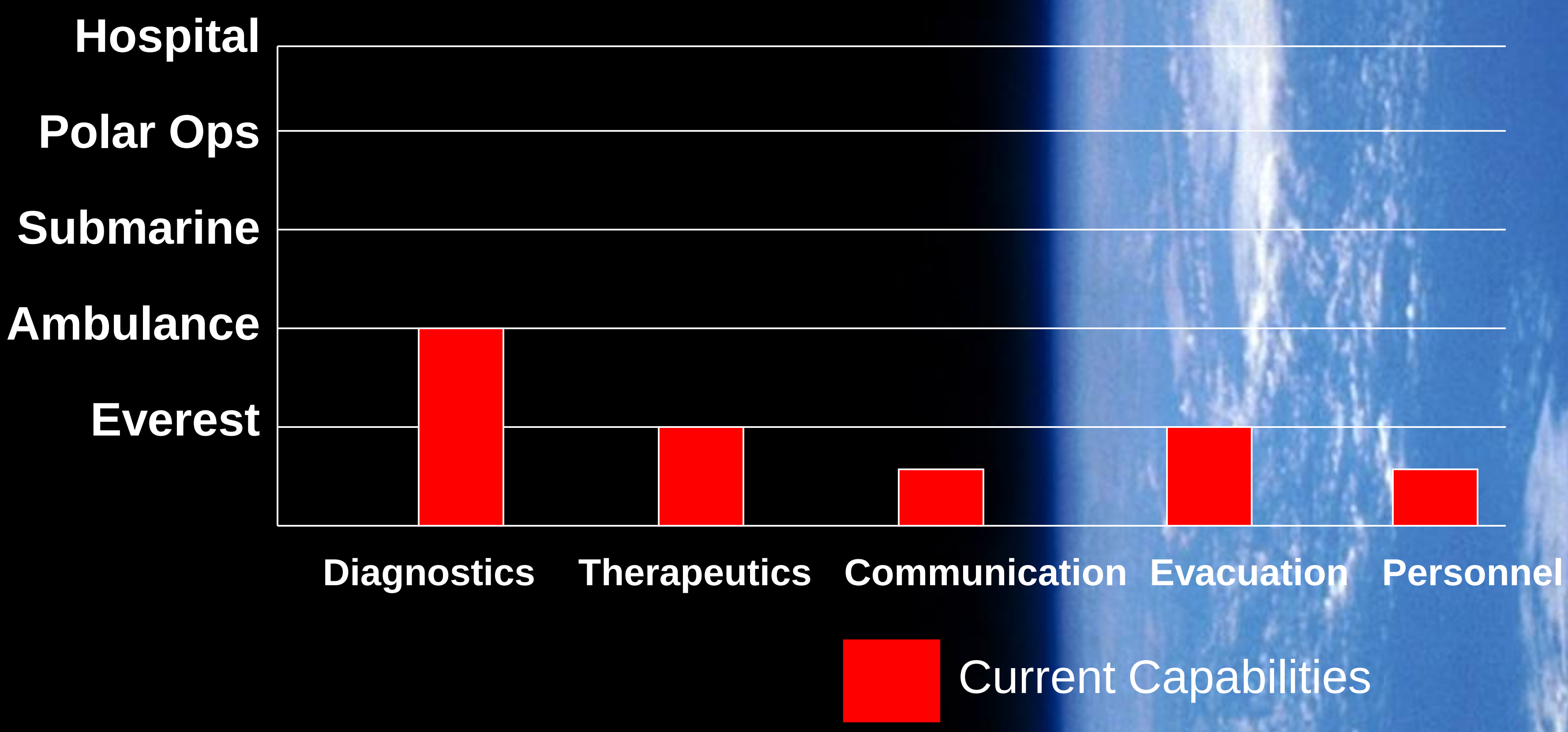


ISS Medical Capabilities Comparison

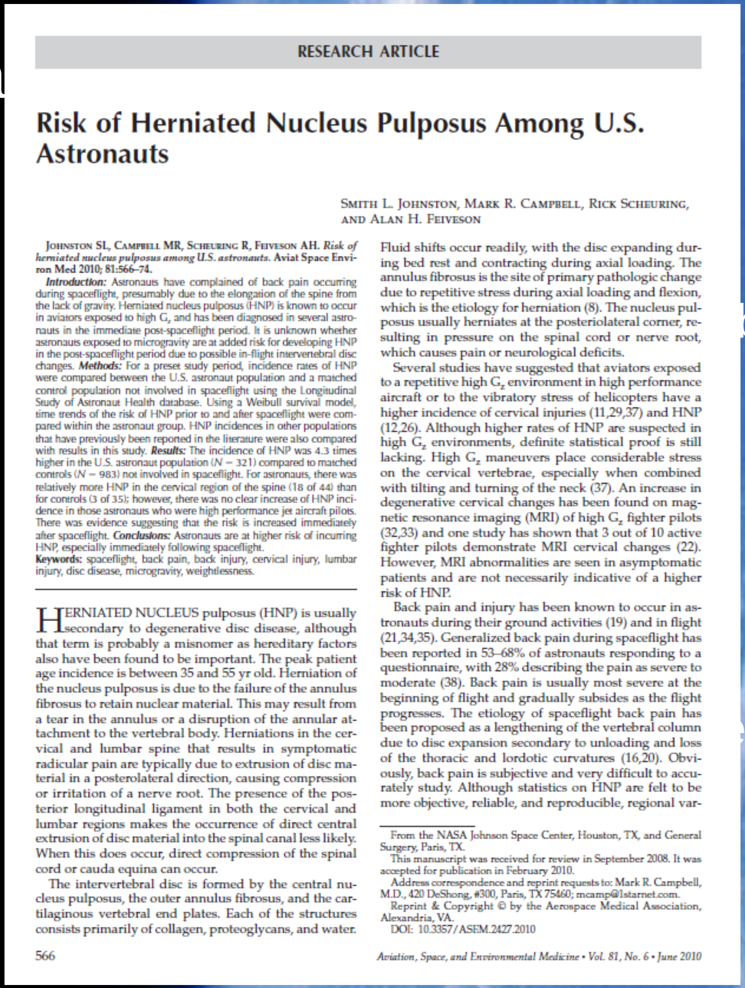


Medical Event or System by ICD9* Category	Number	Percent of Total
Space adaptation syndrome	788	42.2
Nervous system and sense organs	318	17.0
Digestive system	163	8.7
Skin and subcutaneous tissue	151	8.1
Injuries or trauma	141	7.6
Musculoskeletal system and connective tissue	132	7.1
Respiratory system	83	4.4
Behavioral signs and symptoms	34	1.8
Infectious diseases	26	1.4
Genitourinary system	23	1.2
Circulatory system	6	0.3
Endocrine, nutritional, metabolic, and immunity disorders	2	0.1
**International Classification of Diseases, 9th Ed.*		

Medical Events in US Astronauts during space shuttle missions STS-1 through STS-89, April 1981 to January 1998

On orbit medical issues

Ba



RESEARCH ARTICLE

Risk of Herniated Nucleus Pulposus Among U.S. Astronauts

SMITH L. JOHNSTON, MARK R. CAMPBELL, RICK SCHEURING, AND ALAN H. FEIVESON

JOHNSTON SL, CAMPBELL MR, SCHEURING R, FEIVESON AH. *Risk of herniated nucleus pulposus among U.S. astronauts.* Aviat Space Environ Med 2010; 81:566–74.

Introduction: Astronauts have complained of back pain occurring during spaceflight, presumably due to the elongation of the spine from the lack of gravity. Herniated nucleus pulposus (HNP) is known to occur in aviators exposed to high G_z and has been diagnosed in several astronauts in the immediate post-spaceflight period. It is unknown whether astronauts exposed to microgravity are at added risk for developing HNP in the post-spaceflight period due to possible in-flight intervertebral disc changes. ***Methods:*** For a preset study period, incidence rates of HNP were compared between the U.S. astronaut population and a matched control population not involved in spaceflight using the Longitudinal Study of Astronaut Health database. Using a Weibull survival model, time trends of the risk of HNP prior to and after spaceflight were compared within the astronaut group. HNP incidences in other populations that have previously been reported in the literature were also compared with results in this study. ***Results:*** The incidence of HNP was 4.3 times higher in the U.S. astronaut population ($N = 321$) compared to matched controls ($N = 983$) not involved in spaceflight. For astronauts, there was relatively more HNP in the cervical region of the spine (18 of 44) than for controls (3 of 35); however, there was no clear increase of HNP incidence in those astronauts who were high performance jet aircraft pilots. There was evidence suggesting that the risk is increased immediately after spaceflight. ***Conclusions:*** Astronauts are at higher risk of incurring HNP, especially immediately following spaceflight.

Keywords: spaceflight, back pain, back injury, cervical injury, lumbar injury, disc disease, microgravity, weightlessness.

HERNIATED NUCLEUS pulposus (HNP) is usually secondary to degenerative disc disease, although that term is probably a misnomer as hereditary factors also have been found to be important. The peak patient age incidence is between 35 and 55 yr old. Herniation of the nucleus pulposus is due to the failure of the annulus fibrosus to retain nuclear material. This may result from a tear in the annulus or a disruption of the annular attachment to the vertebral body. Herniations in the cervical and lumbar spine that results in symptomatic radicular pain are typically due to extrusion of disc material in a posterolateral direction, causing compression or irritation of a nerve root. The presence of the posterior longitudinal ligament in both the cervical and lumbar regions makes the occurrence of direct central extrusion of disc material into the spinal canal less likely. When this does occur, direct compression of the spinal cord or cauda equina can occur.

The intervertebral disc is formed by the central nucleus pulposus, the outer annulus fibrosus, and the cartilaginous vertebral end plates. Each of the structures consists primarily of collagen, proteoglycans, and water. Fluid shifts occur readily, with the disc expanding during bed rest and contracting during axial loading. The annulus fibrosus is the site of primary pathologic change due to repetitive stress during axial loading and flexion, which is the etiology for herniation (8). The nucleus pulposus usually herniates at the posteriolateral corner, resulting in pressure on the spinal cord or nerve root, which causes pain or neurological deficits.

Several studies have suggested that aviators exposed to a repetitive high G_z environment in high performance aircraft or to the vibratory stress of helicopters have a higher incidence of cervical injuries (11,29,37) and HNP (12,26). Although higher rates of HNP are suspected in high G_z environments, definite statistical proof is still lacking. High G_z maneuvers place considerable stress on the cervical vertebrae, especially when combined with tilting and turning of the neck (37). An increase in degenerative cervical changes has been found on magnetic resonance imaging (MRI) of high G_z fighter pilots (32,33) and one study has shown that 3 out of 10 active fighter pilots demonstrate MRI cervical changes (22). However, MRI abnormalities are seen in asymptomatic patients and are not necessarily indicative of a higher risk of HNP.

Back pain and injury has been known to occur in astronauts during their ground activities (19) and in flight (21,34,35). Generalized back pain during spaceflight has been reported in 53–68% of astronauts responding to a questionnaire, with 28% describing the pain as severe to moderate (38). Back pain is usually most severe at the beginning of flight and gradually subsides as the flight progresses. The etiology of spaceflight back pain has been proposed as a lengthening of the vertebral column due to disc expansion secondary to unloading and loss of the thoracic and lordotic curvatures (16,20). Obviously, back pain is subjective and very difficult to accurately study. Although statistics on HNP are felt to be more objective, reliable, and reproducible, regional var-

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DOI: 10.3357/ASEM.2427.2010

by

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esa
COLUMBUS

Long Hours of Wakefulness Degrades Performance

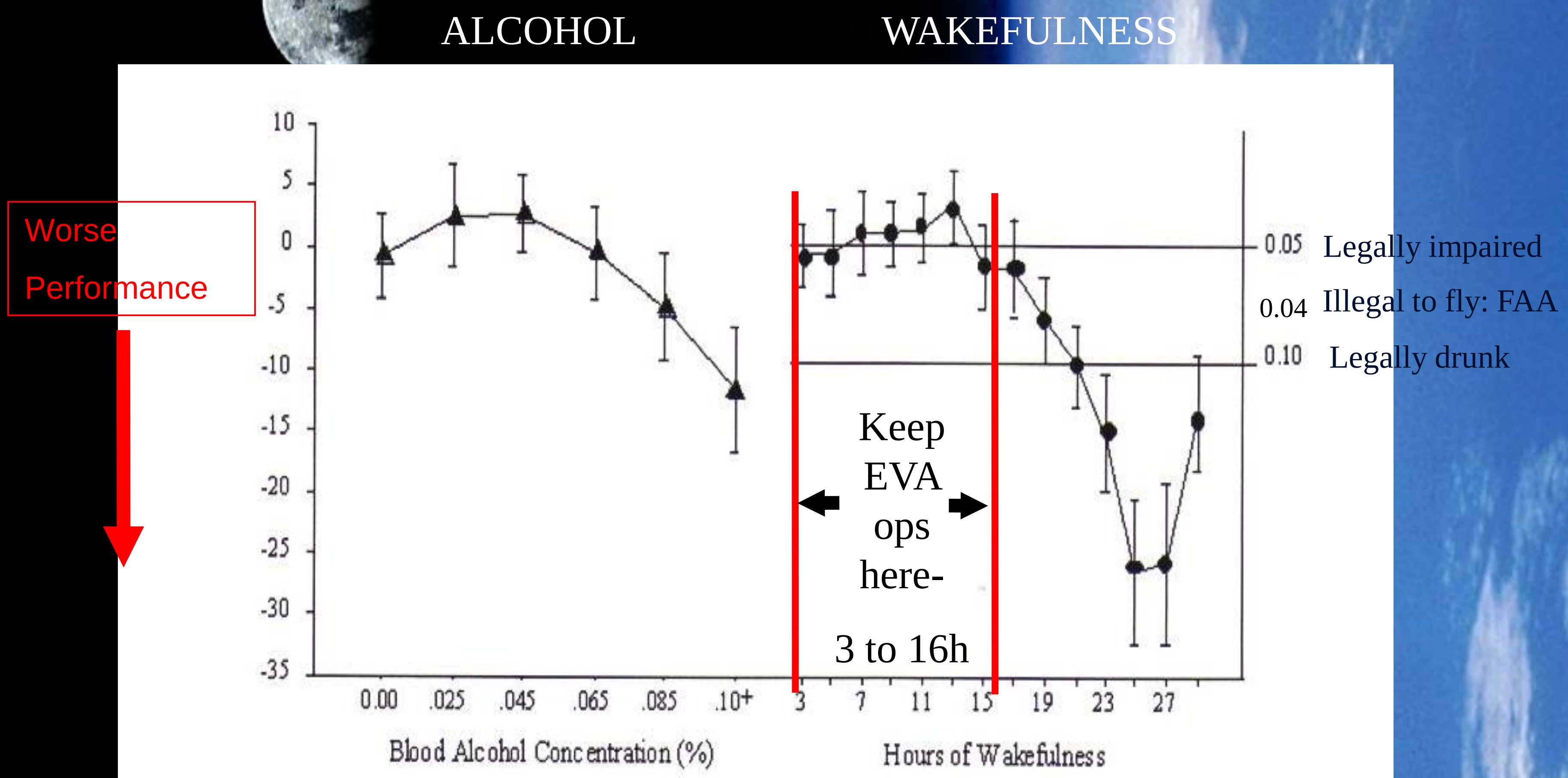
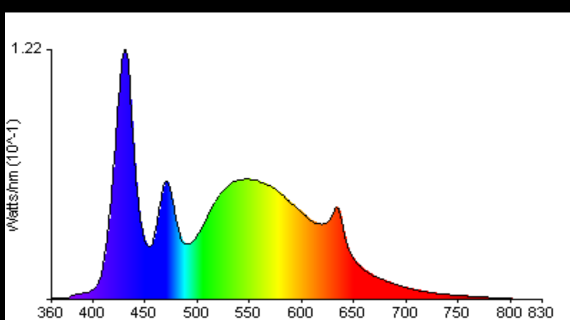


FIG. 1. Mean relative performance levels for the response latency component of the grammatical reasoning task in the alcohol intoxication (left) and sustained wakefulness condition. The equivalent performance decrement at a BAC of 0.05% and 0.10% are indicated on the right hand axis. Error bars indicate ± one s.e.m.

Dawson, D. and Reid, K. Fatigue, alcohol and performance impairment. Nature, 388: 235, 1997

Sleep Countermeasures

Replacement Lights ISS



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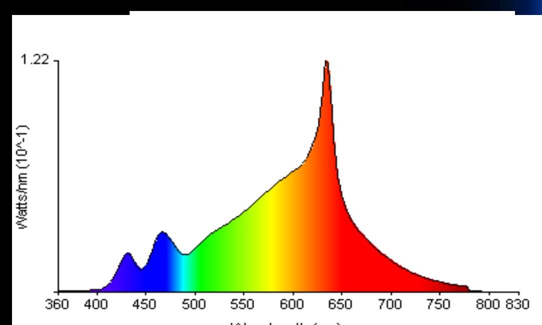
Color: 6500K + emphasize blue deemphasize red



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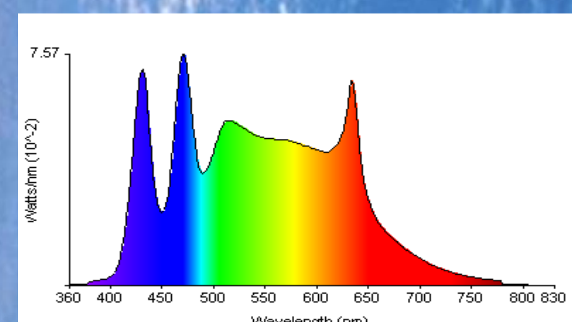
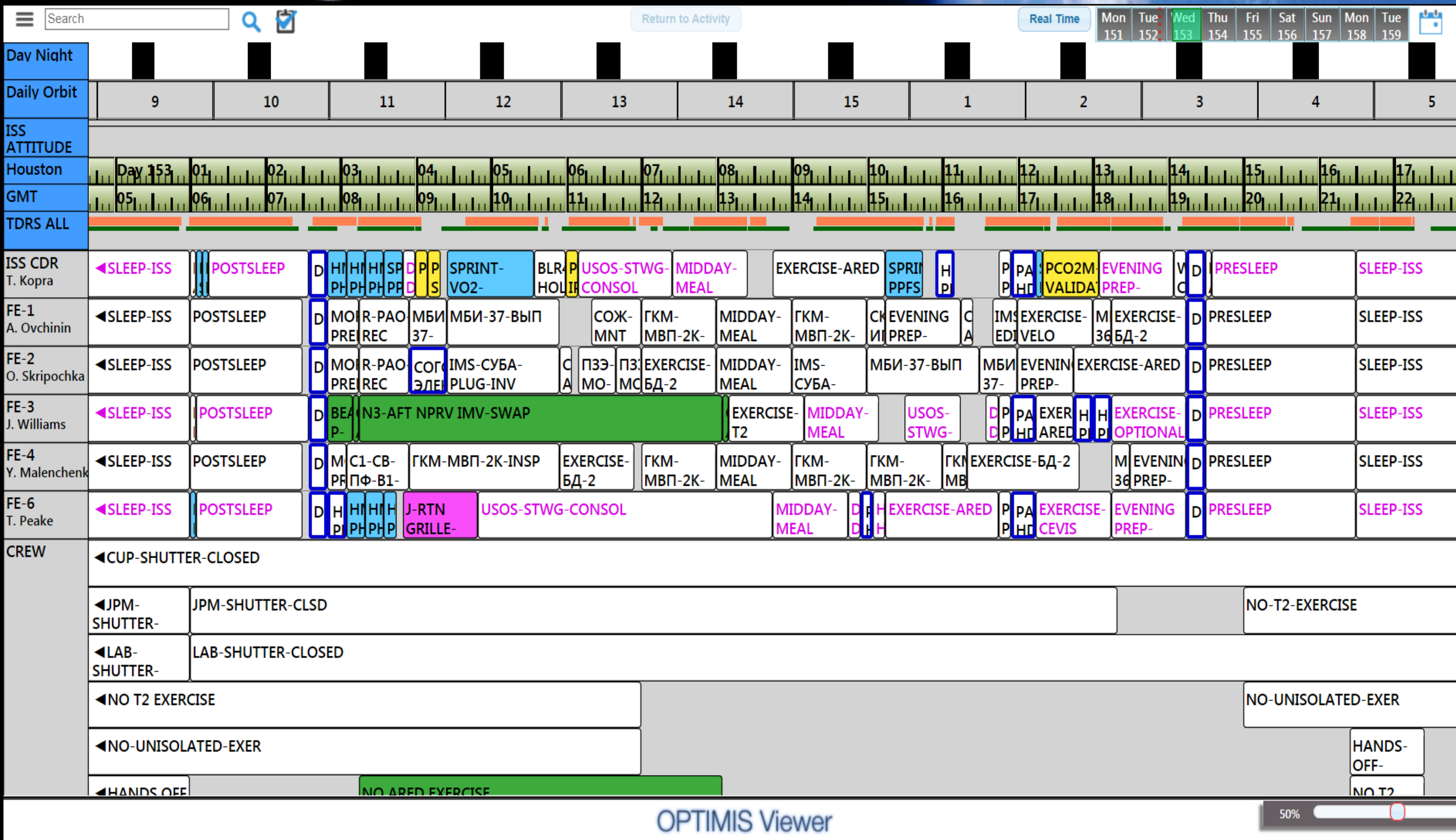
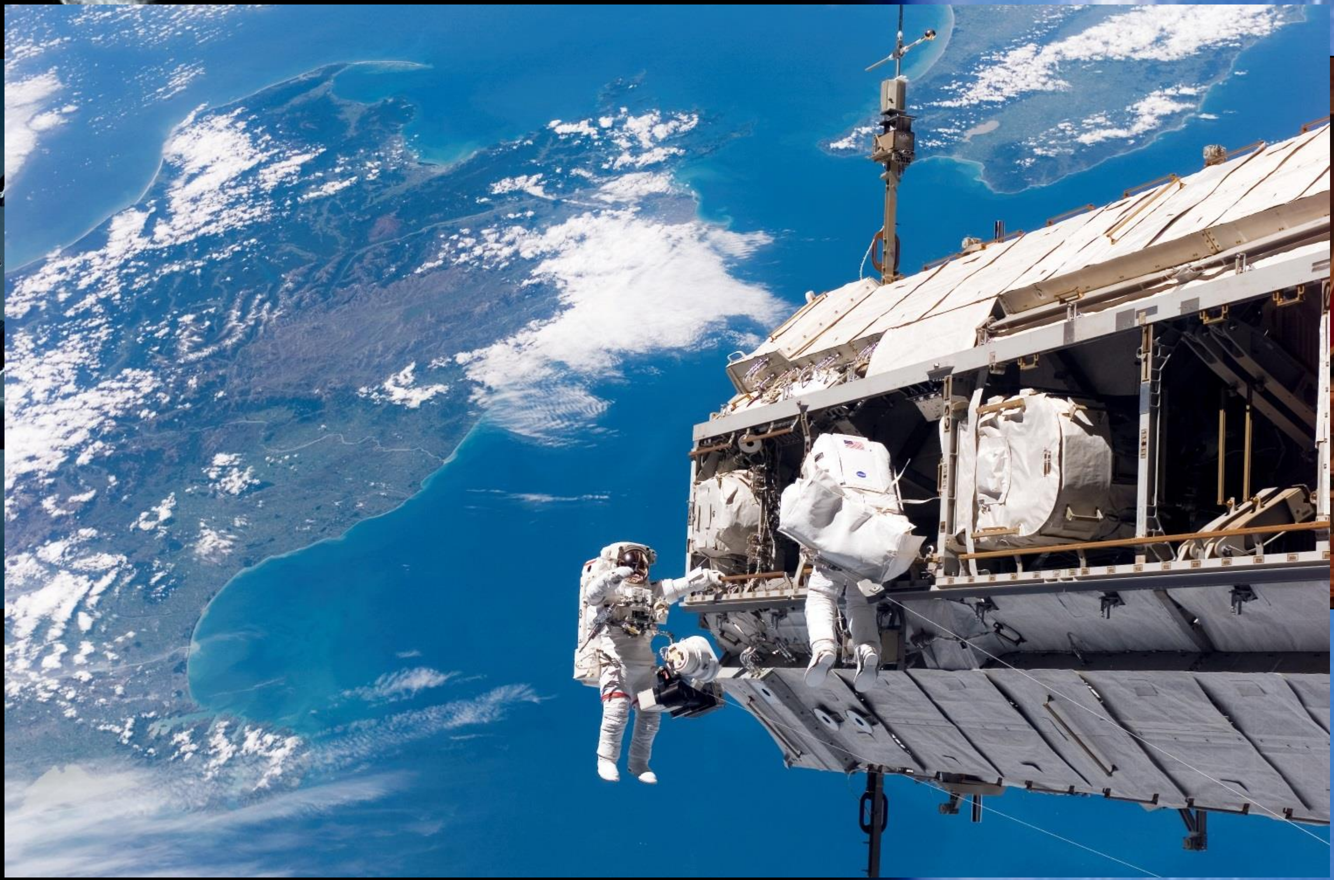


Brightness: 300-500 lux
Color: 4100K full spectrum

On-orbit crew timeline



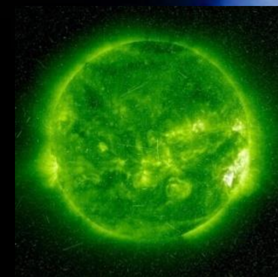
ExtraVehicularActivity (EVA)

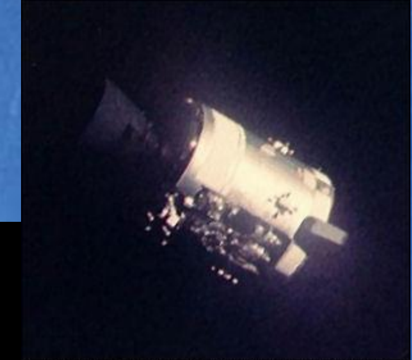


ISS Crew On-Orbit Support

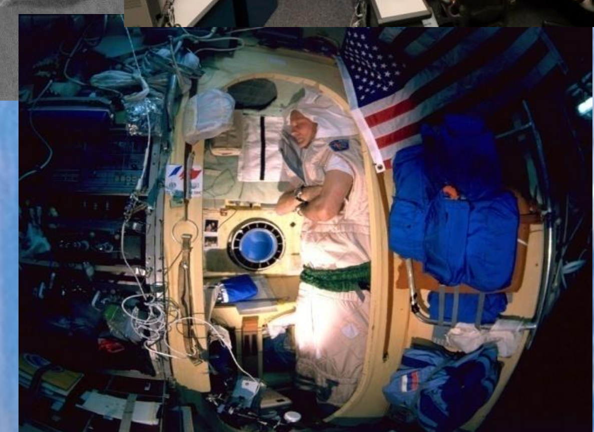
Surgeon Console- WFCR

Hazards of Space Flight



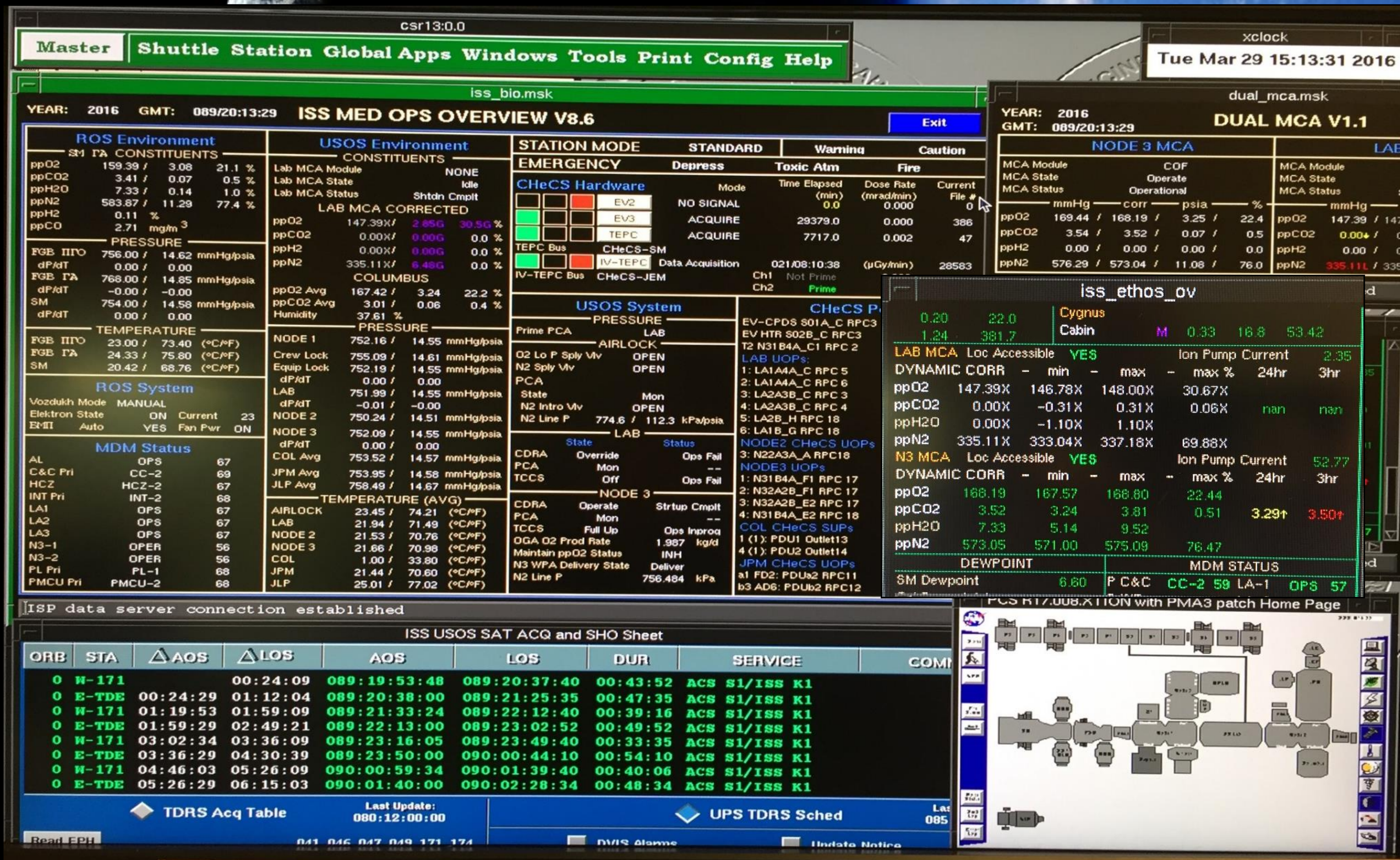


APOLLO 13 SERVICE MODULE (NASA)



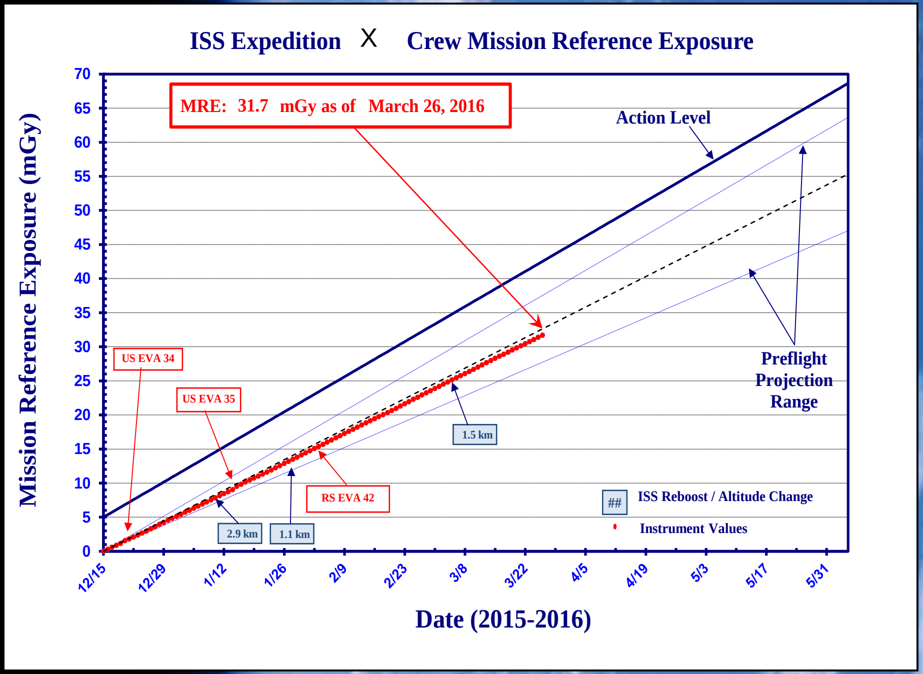
- **Space Environment**
  - Reduced or Micro / Zero Gravity
  - Radiation (GCR / SPE)
  - EVA Extravehicular Activity (Spacewalks)
    - Vacuum (Pressure D)- Decompression Sickness
    - Micrometeoroids / Orbital Debris
  - Interplanetary microbial life (??)
- **Space *Craft* Environment**
  - Toxic Atmosphere
  - Alterations in Gas Concentration (O_2, CO_2)
  - Combustion
  - Thermal
  - Isolation and confinement
  - Noise and Vibration
  - Closed loop environment (life support)
  - Payloads and construction activities
  - Waste production
- **Space *Mission* Environment**
  - Remoteness and time passage / communication delay
  - Flight activity (propulsion, G-forces, impacts)
  - Circadian / Schedule changes

ISS Environment



Radiation

- Exposure based on orbital altitude/inclination, duration, and solar activity
- Crewmembers are radiation workers
  - Limits for mission and career exposure are set by the National Council on Radiation Protection
- As Low As Reasonably Achievable (ALARA) principle for mission planning
- Exposure monitored by active and passive dosimeters



Toxic Products and Propellants

Possib fic
compo

Surgeo ds,
and Li e
hazard

- Fire
- Qui
- Con ts
  (CS
- Air
- Con

Physiological Disturbances Occur During and After G-transitions

Transit

Transit

Earth Postflight

G-transitions **G-transitions**

ISSUES:

Postural and gait instability
Visual performance changes
Manual control disruptions
Spatial disorientation
Motion sickness

OPERATIONAL IMPACT:

Vehicle control
Vehicle egress
Planetary EVAs

Space Shuttle Launch/Landing Support

DoD medical support (“AIRDOC”) for Space Shuttle missions, Kennedy Space Center, FL

Shuttle Launch/Landing Support

- **MCC-Houston**
  - Flight Surgeon
  - Biomedical Engineer (BME)
- **Launch Control Center (LCC) – KSC**
  - Deputy Crew Surgeon (from JSC)
  - EMS Coordinator
  - Cape Biomedical Services Engineer (CBSE)
- **LAUNCH/LANDING SITE RECOVERY AREA (RTLS)**
  - Search and Rescue (SAR)/ MEDEVAC helicopters
    - 1DOD physician per helicopter
    - 1 PJ per flight crewmember
  - KSC Launch Area Clinic
    - Two ambulances with drivers and 4 KSC paramedics
    - JSC Crew Surgeon with triage team
    - One KSC physician and 2 ATLS physicians with triage team
    - Medical consultants on call to DMCF and IMCF

Physiological Considerations- post landing

- Crewmembers return to 1g with 1-2 L loss of plasma volume
  - Equivalent to class II hemorrhage
- Tx N/V with ½ to ¾ normal dose of phenergan
- Avoid succinylcholine and other depolarizing agents which cause ↑ K^+
- Avoid Epi/NE and pavulon which can ↑ myocardial stress through chrono/ionotropic stimulation


NASA
N992NA


Post-flight reconditioning

- Dynamic stretching and warm-up: R+0d
- Mobialanception: R+0d
- Medicine ball: R+0d
- Ladder and cone drills: R+7d
- Jumping drills: R+21d
- Core exercises: R+1d
- Static stretching: R+0d

C-9 Parabolic Flight “Vomit Comet” (Microgravity or Partial Gravity Simulations)

Publications

RESEARCH ARTICLE

Musculoskeletal Injuries and Minor Trauma in Space: Incidence and Injury Mechanisms in U.S. Astronauts

Richard A. Scheuring, Charles H. Mathers, Jeffrey A. Jones, and Mary L. Wear

Scheuring RA, Mathers CH, Jones JA, Wear ML. *Musculoskeletal injuries and minor trauma in space: incidence and injury mechanisms in U.S. astronauts.* **Aviat Space Environ Med 2009; 80:117–24.**

Introduction: Astronauts have sustained musculoskeletal injuries and minor trauma in space, but our knowledge of these injuries is based mainly on anecdotal reports. The purpose of our study was to catalog and analyze all in-flight musculoskeletal injuries occurring throughout the U.S. space program to date. ***Methods:*** A database on in-flight musculoskeletal injuries among U.S. astronauts was generated from records at the Johnson Space Center. ***Results:*** A total of 219 in-flight musculoskeletal injuries were identified, 198 occurring in men and 21 in women. Incidence over the course of the space program was 0.021 per flight day for men and 0.015 for women. Hand injuries represented the most common location of injuries, with abrasions and small lacerations representing common manifestations of these injuries. Crew activity in the spacecraft cabin such as translating between modules, aerobic and resistive exercise, and injuries caused by the extravehicular activity (EVA) suit components were the leading causes of musculoskeletal injuries. Exercise-related injuries accounted for an incidence of 0.003 per day and exercise is the most frequent source of injuries in astronauts living aboard the International Space Station (ISS). Interaction with EVA suit components accounted for an incidence of 0.26 injuries per EVA. ***Discussion:*** Hand injuries were among the most common events occurring in U.S. astronauts during spaceflight. Identifying the incidence and mechanism of in-flight injuries will allow flight surgeons to quantify the amount of medical supplies needed in the design of next-generation spacecraft. Engineers can use in-flight injury data to further refine the EVA suit and vehicle components.

Keywords: astronaut, NASA, strain, sprain, abrasion, contusion, laceration, dislocation, EVA, injury.

NASA ASTRONAUTS face a variety of occupational hazards throughout their career. In addition to the risks inherent to space travel, astronauts perform physically demanding tasks in unfamiliar environments. Coupled with bone and muscle mass loss due to the effects of microgravity on the human body, one could hypothesize that astronauts may be at increased risk for sustaining musculoskeletal injuries while conducting space operations. Indeed, anecdotal reports from astronauts and postflight mission debriefings in all NASA spaceflight programs support this theory, as many astronauts have noted in-flight musculoskeletal injuries. However, until recently, our understanding of these injuries was based primarily on anecdotal reports, without evidence-based data to support these claims.

Jennings and Bagian conducted a study examining the terrestrial-based orthopedic injury history of astronauts during the period of 1987 to 1995 (5). The authors found astronauts sustained numerous fractures, serious ligament, cartilage, or soft tissue injuries, resulting in 28 orthopedic surgical procedures during this period. Knee injuries accounted for 19 of the surgical interventions, while running, skiing, and basketball were the activities most frequently associated with injuries. The authors recommended the hiring of full-time personal trainers and the designation of a facility for training purposes at Johnson Space Center, both of which are now in place as manifested in the Astronaut Strength, Conditioning, and Rehabilitation (ASCR) program. Jennings and Bagian recognized the importance of understanding the mechanism of injury or trauma, noting that it was "time to move beyond documentation of injuries and treatment to providing a program that strives to prevent or mitigate training-related injuries." This important study is often cited in discussions regarding musculoskeletal injuries and prevention in astronauts, but did not address in-flight occurrences.

An article printed in the Longitudinal Study of Astronaut Health (LSAH) newsletter in December 1999 examined the musculoskeletal injury rates of shuttle astronauts between Shuttle Transport System (STS)-1 and STS-89 (12). The authors found an overall greater in-flight injury rate among astronauts than comparison participants in the LSAH. Interestingly, they also found a threefold higher injury rate within astronauts' mission period, defined as 1 yr preflight to 1 yr postflight, versus the rate outside the mission period. This raised questions as to how much of this increase was attributed to preflight training, postflight injury due to de-conditioning, or in-flight injury.

We know that astronauts sustain injuries during the preflight period, especially during training sessions in

From NASA Johnson Space Center, Houston, TX; The University of Texas Medical Branch, Galveston, TX; and Wyle Laboratories, Houston, TX.

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The Apollo Medical Operations Project: Recommendations to improve crew health and performance for future exploration missions and lunar surface operations☆

Richard A. Scheuring[a],*, Jeffrey A. Jones[a], Joseph D. Novak[b], James D. Polk[a], David B. Gillis[a], Josef Schmid[a], James M. Duncan[a], Jeffrey R. Davis[a]

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Abstract

Introduction: Medical requirements for the future crew exploration vehicle (CEV), lunar surface access module (LSAM), advanced extravehicular activity (EVA) suits, and Lunar habitat are currently being developed within the exploration architecture. While much is known about the vehicle and lunar surface activities during Apollo, relatively little is known about whether the hardware, systems, or environment impacted crew health or performance during these missions. Also, inherent to the proposed aggressive surface activities is the potential risk of injury to crewmembers. The Space Medicine Division at the NASA Johnson Space Center (JSC) requested a study in December 2005 to identify Apollo mission issues relevant to medical operations impacting crew health and/or performance during a lunar mission. The goals of this project were to develop or modify medical requirements for new vehicles and habitats, create a centralized database for future access, and share relevant Apollo information with various working groups participating in the exploration effort.

Methods: A review of medical operations during Apollo missions 7–17 was conducted. Ten categories of hardware, systems, or crew factors were identified during preliminary data review generating 655 data records which were captured in an Access® database. The preliminary review resulted in 285 questions. The questions were posed to surviving Apollo crewmembers using mail, face-to-face meetings, phone communications, or online interactions.

Results: Fourteen of 22 surviving Apollo astronauts (64%) participated in the project. This effort yielded 107 recommendations for future vehicles, habitats, EVA suits, and lunar surface operations.

Conclusions: To date, the Apollo Medical Operations recommendations are being incorporated into the exploration mission architecture at various levels and a centralized database has been developed. The Apollo crewmember's input has proved to be an invaluable resource. We will continue soliciting input from this group as we continue to evolve and refine requirements for the future exploration missions.

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Keywords: Apollo; Lunar surface operations; Moon; EVA; Astronauts

1. Introduction

The Apollo Program, which began in January of 1966, was composed of 18 missions: 12 crewed missions (including the Apollo 204 mission with Virgil

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Physiological Issues in Partial Gravity

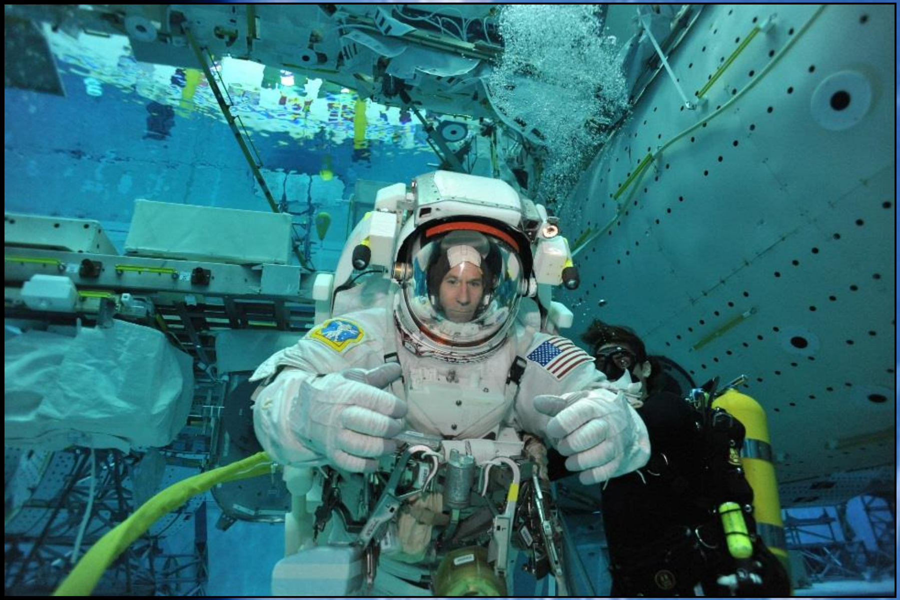
- Apollo lunar crews adapted quickly to the 1/6g environment
  - Initial unsteady gait related to EVA suit CG issues ***not*** neurovestibular dysfunction
  - Forearm and upper extremity fatigue attributed to glove design
  - Inadequate sleep, dietary caloric intake experienced by most crewmembers
  - Other physiologic function (cardiovascular, bone) unknown
- SMS did not recur upon return to microgravity

NBL EVA Training

- Each training run is approximately 6 hrs in duration
- Training EVA: Spaceflight EVA ~6-10:1
- Suit pressurized to 4.3 psi/100% O_2

Extravehicular activity Mobility Unit (EMU) Training Injuries

- **Shoulder**
  - rotator cuff tendonitis, SASD bursitis, LHBT tenosynovitis, SLAP lesion, impingement syndrome, anterior impingment (subscapularis), AC joint pain, GH joint pain
- **Elbow**
  - lateral epicondylitis, radial/cubital tunnel syndromes
- **Forearm/wrist**
  - Dequervan's tenosynovitis, Extensor Pollicis Longus (EPL) tendonitis, carpal tunnel syndrome
- **Fingers**
  - onycholysis
- **Spine**
  - cervical, thoracic strain, lumbar spasm

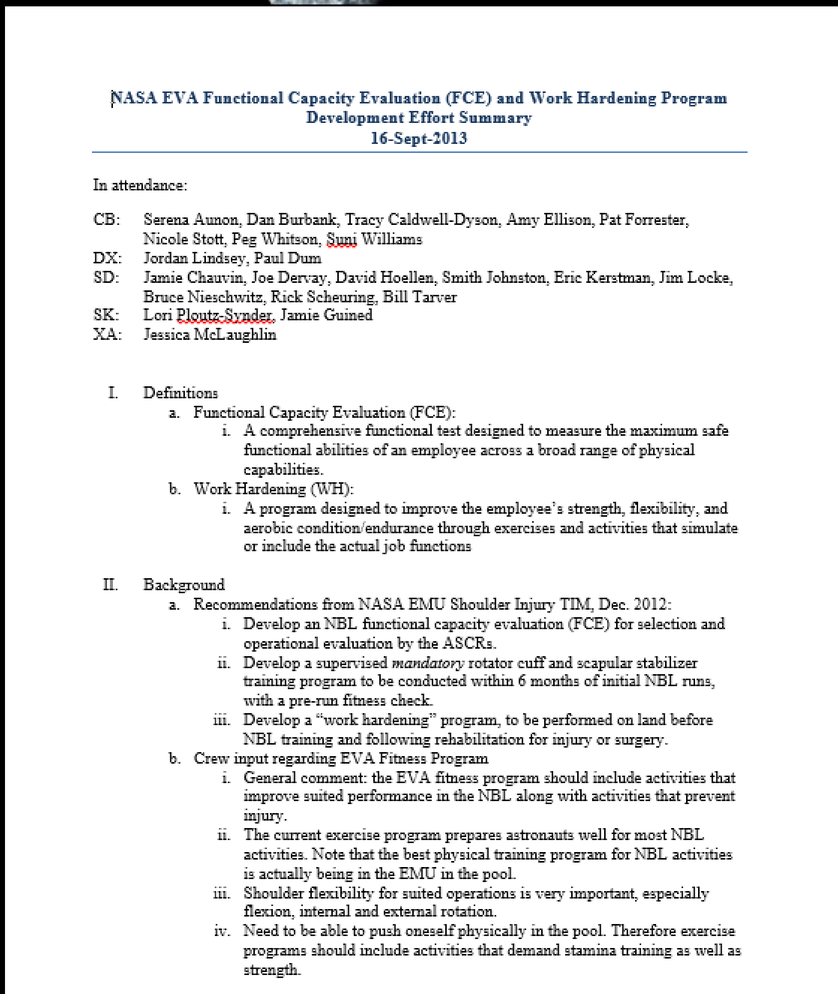


Sickness, Wellness and Fitness

- Wellness
- Sickness
- Fitness

Measurements:
-Blood Pressure
-Body Fat
-Bone Density
-Cholesterol
-Flexibility
-Muscle Mass
-Etc

NBL EMU Work Hardening Program



NASA EVA Functional Capacity Evaluation (FCE) and Work Hardening Program
Development Effort Summary
16-Sept-2013

In attendance:

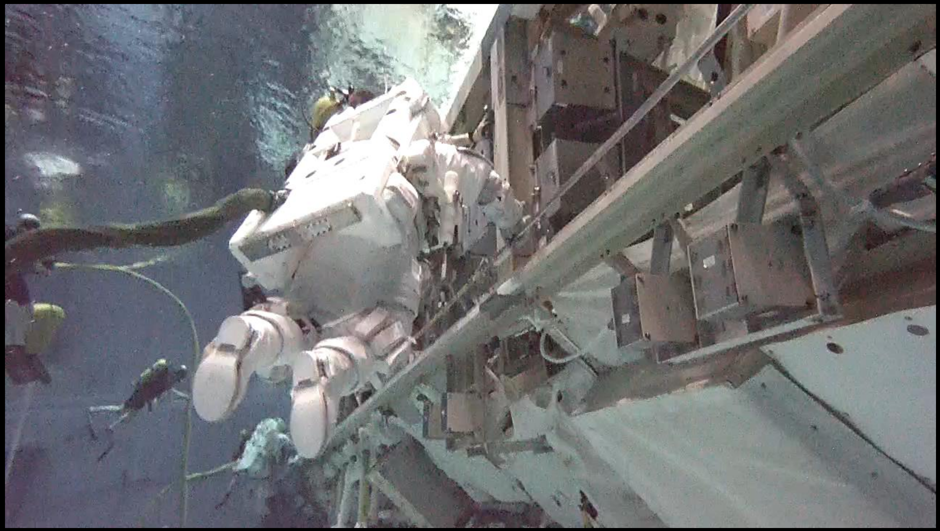
CB: Serena Aunon, Dan Burbank, Tracy Caldwell-Dyson, Amy Ellison, Pat Forrester, Nicole Stott, Peg Whitson, Suni Williams
DX: Jordan Lindsey, Paul Dum
SD: Jamie Chauvin, Joe Dervay, David Hoellen, Smith Johnston, Eric Kerstman, Jim Locke, Bruce Nieschwitz, Rick Scheuring, Bill Tarver
SK: Lori Ploutz-Synder, Jamie Guined
XA: Jessica McLaughlin

I. Definitions
   a. Functional Capacity Evaluation (FCE):
      i. A comprehensive functional test designed to measure the maximum safe functional abilities of an employee across a broad range of physical capabilities.
   b. Work Hardening (WH):
      i. A program designed to improve the employee's strength, flexibility, and aerobic condition/endurance through exercises and activities that simulate or include the actual job functions

II. Background
   a. Recommendations from NASA EMU Shoulder Injury TIM, Dec. 2012:
      i. Develop an NBL functional capacity evaluation (FCE) for selection and operational evaluation by the ASCRs.
      ii. Develop a supervised *mandatory* rotator cuff and scapular stabilizer training program to be conducted within 6 months of initial NBL runs, with a pre-run fitness check.
      iii. Develop a "work hardening" program, to be performed on land before NBL training and following rehabilitation for injury or surgery.
   b. Crew input regarding EVA Fitness Program
      i. General comment: the EVA fitness program should include activities that improve suited performance in the NBL along with activities that prevent injury.
      ii. The current exercise program prepares astronauts well for most NBL activities. Note that the best physical training program for NBL activities is actually being in the EMU in the pool.
      iii. Shoulder flexibility for suited operations is very important, especially flexion, internal and external rotation.
      iv. Need to be able to push oneself physically in the pool. Therefore exercise programs should include activities that demand stamina training as well as strength.

- Match physical fitness training with NBL tasks to improve EVA performance (from ASCRs)
  - **Grip tasks**- kettlebell swings, dumbbell crawl
  - **Shoulder tasks**- handstand push-ups, push press, Farmer's walk
  - **Core/Back**- RDL's, axle-wheel row, back extensions
  - **Articulating portable foot restraint (APFR) ingress**- Squats, lunges, box jumps
  - **Inverted operations**- Windmills, battle ropes, overhead bag toss

NBL EMU Work Hardening Program



Dumbbell “astronaut” crawl

Axle-wheel row

4 September 2018

Astronaut Selection Support

- 2013: over 6,000 applicants for 8 positions
- 2017: approx. 19,000 applications for estimated 12-15 positions
- Flight medicine team performs evaluations on 120 finalists and in-depth examinations and studies in the final 50 cut

2017 Astronaut Selection Schedule

Feb 2016 → June 7, 2017

18, 357 Applicants → 11,886 Qualified → 439 Highly Qualified → 120 Semi-Finalists → 50 Finalists → 12 ASCANs

0.065% selection rate (all applicants)
0.10 % selection rate (qualified applicants)
2.7% selection rate (highly qualified applicants)

Additional factors that drove up application interest included the movie The Martian and NASA's use of social media to advertise the job opening.

NASA Military Physician Astronauts

Frank Rubio, MD
Army Ranger/Blackhawk Pilot

Jonny Kim, MD
Navy SEAL

Drew Morgan, MD
Army Ranger/Flight Surgeon

How do you do it?

- Medical school
- Aerospace Medicine Clerkship
  - NASA-JSC
- Internship/residency
  - FM, IM, EM, etc
- Aerospace Medicine Residency (RAM)
  - WSU, UTMB, Mayo
  - Military

How do you do it?

Military medicine is not synonymous with medicine in the military

- Combat Casualty Care Course (C4)
- Tactical Combat Care Course (TC3)
- Tactical Medical Care Course (TCMC)

- Aerospace Medicine Clerkship
  - NASA-JSC

Army Aerospace Medicine

- The RAM program provides an overview of space operations over a 1-2 week period
- A NASA flight surgeon requires 2-3 years of training to be qualified to meet certification standards to practice operational space medicine
- NASA-JSC is the only training facility in the US that fully trains and conducts manned space operations

COL Rick Scheuring and MAJ Courtney Hayes on console in the Mission Control Center flight control room 1 (FCR1) in Houston, TX

What's Next?

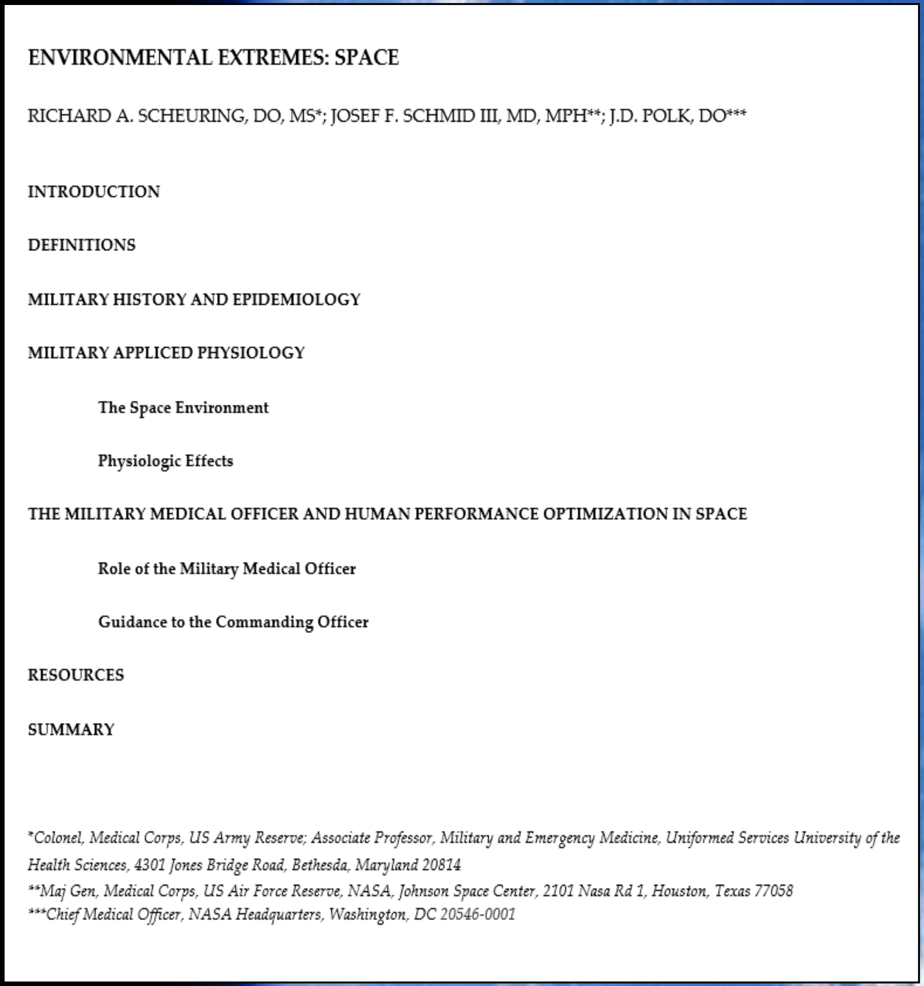
ISS Expedition 60/61 Jul, 2019

Natives by Pat Rawlings, 1998.

?

The Changing Battlefield

Announcement of Space Policy Directive 3 (SPD3) June 18, 2018



ENVIRONMENTAL EXTREMES: SPACE

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Questions?