ORGANIZATION, MANAGEMENT AND FUNCTION OF INTERNATIONAL SPACE STATION (ISS) MULTILATERAL MEDICAL OPERATIONS

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A Multilateral Operational System

ISS is unique and highly successful in terms of creating an international operational medical system.
Purpose of Space Medicine

For every mission / crewmember
- Protecting and improving health and performance
- Preventing long-term health consequences
- Responding to trauma or illness

Long-Term
- Improving medical capabilities in microgravity
- Advancing knowledge in space medicine
- Advancing the practice of medical telemetry and telemedicine
- Preparing for future missions
In search for solutions, space medicine has been developing, using, and promoting advanced technologies to deliver health care.

During the last decade, space medicine experts from several nations have shared a common goal of supporting the ISS Program.
Salyut, MIR, Skylab Stations
Short-Duration Missions
Submarine, Antarctic, and Other Isolated Crews
Growing own experience base
SECTION I: ISS MEDICAL ORGANIZATION
ISS Medical Authority Structure

- Multilateral Medical Policy Board (MMPB)
- Multilateral Space Medicine Board (MSMB)
- Multilateral Medical Operations Panel (MMOP)

ISS Program

Multilateral Mission Integration and Operations Control Board (MMIOCB)

NASA  CSA  ESA  JAXA  FSA
Multilateral Medical Operations Panel (MMOP) - 4 Phases

3. ISS Early Operations: 2000 – Assembly Complete
4. ISS Routine Operations: 2008 – Lifetime
Initial Period 1995-1996

- **Challenges**
  - Different medical cultures and standards of care
  - Diverse medical backgrounds, training, and experience
  - Different expectations about ISS medical system
  - Different management structures
  - Variable funding levels
  - Expected to operate by consensus
Pre-Operational Period (1997-2000)

- Build a unified team
- Establish relationship with the engineering community
- Develop joint operational concepts
- Develop requirements and standards acceptable to all partners and the ISS Program management
- Develop implementation plans and other documentation
- Activate MMOP working groups
- Share experience and knowledge
Operational Period

• MMOP functions as a Working level body for coordinating partner inputs for ISS medical operations
• Develops medical standards and requirements
• Establishes medical operations implementation plans
• Establishes crew biomedical training programs
• Establishes flight surgeon training programs
• Oversees medical data handling issues
Multilateral Medical Operations
Panel Structure

NASA  CSA  ESA  JAXA  RSA

Space Medicine Operations Team

Multilateral Medical Operations Panel

Spaceflight Human Behavior & Performance
Countermeasures
Radiation Health

Medical Standards and Health Evaluation
Nutrition
Extravehicular Activity

Inflight Clinical Space Medicine
Environmental Health
Biomedical Training

Medical Informatics and Technology
Postflight Activity & Rehabilitation
MMOP in ISS Operations

• Management of further integration of all partners
• Multilateral consideration of Partner-initiated input into ISS medical operations
• Development of multilateral consensus medical position on programmatic issues (e.g., on planning of missions > 180 days)
• Development of multilateral inputs into ISS medical or medically relevant documentation, and multilateral document control
• Provision of medical input into the ISS Program on a regular basis; regular reports to ISS MIOCB
MMOP Products

- ISS requirements documentation
  - Medical (operations, medical evaluation, etc.)
  - Pertinent sections of other space station documents
    - ISS ground rules and scheduling constraints
    - ISS operational flight rules
    - Increment – specific requirements
- Implementation plans and other documentation

- Crew health and safety
- Medical risk mitigation
Supervision and Adjustment of Routine Operations

Weekly Space Medicine Operations Team (SMOT)

Weekly coordination and status/issues

• Crew health and well-being, work/rest schedule
• Hardware, medical procedures, environment, radiation
• Data management and exchange
• Generation of medical input for the ISS Mission Management Team (MMT) and short-term planning
• Any urgent matters and announcements, problem resolution
• Readiness for events, “look-ahead” reviews

Has taken place >330 times (as of May 2006)
Medical Certification: ISS
Multilateral Space Medicine Board

- Review and approval of medical certification for duty on ISS
- Credentialing and certification of physicians to practice space medicine on ISS

ISS has joint Medical standards are common for all

- Space flight eligibility standards
- Medical selection and periodic evaluation requirements
- Pre-, in- and postflight evaluation requirements
- Medical standards and evaluation requirements for Space Flight Participants
Principles of ISS Certification

- Common standards and evaluation requirements
- Common responsibility for health and well-being of crews and mission success
- Independence of administrative influence
- Common presentation format
- Full disclosure of available data
- Meticulous clinical review / discussion
- Increasing use of terrestrial and space evidence
- Multilateral decision-making by consensus
- Building new knowledge through learning from each other and sharing expertise
MSMB member informs Agency
Flight Crew office
Medical board
Flight medicine clinic

MSMB notifies MMPB, MCOP

PARTNERS’ PROCESS

Presentation to MSMB
Consensus?

Consensus?

Second attempt to reach MSMB consensus

Consensus?

3rd Attempt Recommended?

Third attempt to reach MSMB consensus

MMPB reviews the process and provides recommendations to MSMB

Consensus?

Medical Process Complete; Medical Certification for ISS Granted

Medical Process Complete; Medical Certification for ISS Denied

Returned to Agency for Additional Workup

Consensus?

Consensus?
Crew Certification Data (to be updated)

- **Total number of individuals:** 115
- **Total number of certification events:** 210
  - *Average: 1.83 events per person*
Distribution by Standards Applied

- **Long - Duration Space Flight (ISS Crewmembers or candidates)**
  - (30 – 180 days)

- **Short - Duration Space Flight (Soyuz or Shuttle crewmembers) to visit ISS (up to 30 days)**

- **Space Flight Participants to visit ISS (Individuals who are not astronauts or cosmonauts by profession)**
Total number of ISS Flight Surgeons: 31
SECTION II: ISS MEDICAL OPERATIONS
• 14 missions aboard the ISS were completed successfully
• The health outcomes of ISS missions continue to be favorable
• Nominal mission duration = 180 days
Exp.15 “core” launched in April 07
Medical Launch Readiness Checklist Areas

- Crew medical certification and clearance for launch
- Crew training
- Capabilities for evaluation and monitoring of crew health and performance
- Capabilities for diagnosis and treatment
- ISS environment and capabilities for environmental monitoring
- Capabilities for sustaining human health (in-flight countermeasures, food and water supply, compliance with crew day planning requirements and work-rest schedule limitations)
Mission Status and Readiness Reviews

Any day has been “Looked Ahead” by means of:

1. Mission: MMOP Expedition/Mission RR
3. Weekly: SMOT
4. Daily: IMG Mission Status Reports
The Integrated Medical System

- This concept of the Integrated Medical System (IMedS) goes beyond nomenclature; it is in fact the way ISS Medical Operations works.
- All operational medical equipment and systems are considered part of IMedS, regardless of their origin.
- Most medical operations equipment contributed by Partners is mutually complementary, with certain redundancy for critical systems.
Example: The System of Countermeasures
Example: OUM/PFE
- Has been used successfully for 3 PFEs
Transition to Multilateral Crews

• STS-121 delivered an ESA astronaut to the ISS

• T. Reiter’s / Astrolab mission marks a transition towards multilateral crews
Partner “Concepts of Operation”

- In the foreseeable future, JAXA, ESA and CSA astronauts will serve as ISS crewmembers.
- Each Agency has largely similar sets of solutions for the medical support of their astronaut.
- We expect considerable expansion of the current Integrated Medical Group and contribution from other Partners into joint Medical Operations.
- The expected increase in the size of the crew will pose new challenges and require efforts to revisit and re-validate many aspects of the system.
The ISS Program continues to receive consensus input on the medical operational aspects of the ISS Program.

In the limited-resource environment of the ISS, a high degree of integration allows to maintain all the necessary capabilities to maintain crew health and safety and ensure favorable medical outcomes.

The ISS medical organization is building valuable evidence base for the space medicine of future.
SECTION III: OPERATIONALLY ORIENTED RESEARCH, TECHNOLOGY DEVELOPMENT, AND FUTURE MISSIONS
Telemedicine Methodology for ISS: Diagnostic Imaging
New Diagnostic Methods and Approaches

Hemothorax

Pneumothorax
Use of Internet for Remote Consultant Capability
Duration-Related Human Health Concerns

**Behavioral Health & Performance**
Extended duration influences human behavior and performance
Family separation, missed personal goals and milestones
Stress from multiple factors

**Clinical Care Capability**
Extremely limited ability to treat significant conditions on orbit, with further reduced medical care during return

**Human Adaptation & Countermeasures Issues**
Countermeasures not validated for deconditioning effects of extended duration spaceflight

**Habitability and Environmental Issues**
Radiation Effects are duration dependent (cancer and non-cancer)
Regulatory radiation exposure limits
High noise level in spacecraft may impair hearing
Environmental sample and nutrition concerns with longer resupply cycle
The Future of Space Medicine

- As part of the work for ISS and future missions, technologies are / will be adapted or created in:
  - Medical informatics
  - Smart medical and environmental sensors
  - Decision support systems
  - Medical data / image compression and handling
  - New teaching aids - enhanced training, skill retention, and just-in-time performance enhancement
  - Virtual presence technologies and adaptive expertise delivery (remote guidance) systems
  - Noninvasive and minimally invasive diagnostic and treatment procedures
  - Novel solutions in preventive medicine