The aeromedical challenges of commercial space flight

Lt. Col. Francesco Torchia

2nd International Symposium “Hypersonic Flight: from 100,000 to 400,000 ft”

1983

Charlie Walker
1° Commercial payload specialist

2001

Dennis Tito – 1° space tourist
Flight Domains

Commercial orbital spaceflight

Private companies winner of NASA Commercial Resupply Service (CRS) Program

- Space X – Dragon
- Orbital Corporation – Cygnus
Commercial orbital spaceflight

**NASA Commercial Crew Development (CCDev2) Program**

- **Space X**
  - Dragon V2 manned

- **Boeing**
  - CST-100

**Commercial orbital space flight**

- **Excalibur Almaz**
- **Denis Tito’s Mars Inspirations**
- **Planetary Resources Space Adventures**
Commercial suborbital space flight

Virgin Galactic Spaceship 2
- will fly over 100 km
- 2 pilots + 6 passengers
- 3-hours suborbital flight
(3-4 minutes of microgravity)

Lynx flight path
Most of the medical and physiological data collected to date are based on the effects of space flight on generally normal and healthy individuals (career astronauts and cosmonauts).

**Commercial orbital flights**

**Space tourist Gregory Olsen**
- 57ys old: history of pneumothorax, moderately severe emphysema, bilateral parenchymal bullae, mediastinal mass, ventricular and atrial ectopy
- Received preventive treatment of these conditions, before being cleared to fly in space
- Completed medical evaluation in analog environments (altitude chamber, high altitude mixed-gas simulation, zero-G flight, high-G centrifuge)

Commercial orbital flights

Dr. Eng. Gregory Olsen

• Had no difficulties during the training and performed well during spaceflight

• Post-flight medical testing showed that he was in excellent condition and unchanged medically by the flight

Jennings RT et al. “Medical Qualification of a Commercial Spaceflight Participant: Not Your Average Astronaut.” Aviat Space & Environ Med, 2006. (Dr. Olsen released his medical data)

Consequences of microgravity
Future space voyager

- A good compromise between:
  - Safety of passengers and of the flight
  - Avoiding imposing an obstacle to the successful establishment of the manned space transportation industry
  - To consent a larger subset of population to participate in future space exploration

- 1-time medical clearance for 1-flight passenger
- Crew: repetitive suborbital flights

Shuttle Medical standards

<table>
<thead>
<tr>
<th>Item</th>
<th>Pilot (Class I)</th>
<th>Mission Specialist (Class II)</th>
<th>Parachute Specialist (Class III)</th>
<th>Participant (Spaceflight in Class IV)</th>
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<td>-5° to 15°</td>
<td>-5° to 15°</td>
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<td>Balance</td>
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</table>

4 classes based on Astronaut position

- Class I and II differ only for visual acuity and height
- Class IV: Spaceflight Participants (never used)
ISS Medical Requirements

- **Medical Volume A**
  - ISS long spaceflights

- **Medical Volume B**
  - Medical operations

- **Medical Volume C**
  - Spaceflight Participants
    - No deformities
    - Emergency egress capabilities
    - Preflight Training completed

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**Medical Guidelines for Space Passengers**

AEROSPACE MEDICAL ASSOCIATION TASK FORCE ON SPACE TRAVEL
Medical guidelines for space passengers. Astral Space Travel Med. 2001; 7(4):

COLDVOYAGE
- Coronary Artery Disease
  - Symptomatic = DQ
  - Asymptomatic = Evaluate for exception
- Arrhythmias/Conduction Defects
  - Prenotodynamically significant = DQ
  - Systolic/Diastolic = Evaluate for exception
- Pacemaker/Implantable Defibrillators = DQ
- Pericarditis/Mycarditis
  - DQ
- Evaluate 6 months post-recovery
- Brain Transplant/Replacement
  - DQ
- Hypertension
  - Severe or poorly controlled = DQ
  - Well Controlled = Qualified with possible exceptions
- Structural/Valvular Defects
  - Symptomatic = DQ
  - Asymptomatic = Evaluate for exception
- Cardiomyopathy
  - Symptomatic = DQ
  - Asymptomatic = Evaluate for qualification

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Aerospace Medical Association
Task Force on Space Travel
2001
(orbital)
Medical Guidelines for Space Passengers—II

2002 “assumptions” (suborbital flights)

- Space vehicle interior small and confining
- Suborbital flight 1 to 3 hr including x min. microgravity
- Cabin pressurized to sea level or 5-8000 ft.
- No life support equipment required
- Acceleration will range between 2 – 4.5 +Gz or Gx (depending on the space vehicle)
- Different emergency procedure (depending on the space vehicle)
- Few or no medical capabilities onboard

What potential risks should be disclosed?

What is an appropriate/sufficient full-disclosure of potential risks that would:

- Minimize liability for the operator?
- Not produce excessive fear among prospective space participants?
How conservative should medical screening guidelines be for space passengers in order to:

Promote the preservation of life and the safety of the flight?

*and at the same time*

Avoid imposing an obstacle to the successful establishment and growth of the manned commercial space transportation industry?

Future space voyager

- **Commercial Space Launch Amendment Act (2004):** US is the only country that established licensing requirements
  “Passengers to be fully informed about the potential risks but allowing to fly at their own risk”

**SPACE FLIGHT SURGEON**

as

**RISK MANAGER**

that may recommend a risk mitigation strategy
Future space voyager

- FAA 2005 “Guidance for Medical Screening of Commercial Aerospace Passengers”
  
  **Suborbital**: medical history and physical assessment decided by the space Flight Surgeon
  
  **Orbital**: medical history and standardized physical assessment

- FAA (2006): “Human spaceflight requirements for crew and spaceflights participants”
  - Informed consent on risks of spaceflight
  - FAA Airmen Class II for crew (now Class I)
  - Only medical guidelines for passengers

Medical Requirements

- FAA (2006): “Human spaceflight requirements for crew and spaceflights participants”
  - Informed consent on risks of spaceflight:
    “An operator must inform in writing any individual serving as crew that the US Gov has not certified the launch vehicle and any reentry vehicle as safe for carrying flight crew or space flight participants...before entering into any contract”

- FAA Centre of Excellence for Commercial Space Transportation
  - Medical Guidelines 2012

- International Association for the Advancement of Space Safety (IAASS)
  - Medical guidelines 2014
  - Radiation limits for suborbital flights
Preflight clearance

**Human Centrifuge**

**Gagarin Centre**

**Parabolic flight**

**NASTAR Centre**

Challenges

- Elderly people
- Pregnant women
- Operational medicine
Operator-owned medical databases will be of critical importance (medical & legal) to the success of the manned commercial space transportation industry, and, more importantly, to the health and safety of subsequent space flight participants.