NASA Medical Response to Human Spacecraft Accidents

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Disclosure Information
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• I have no financial relationships to disclose.
• I will not discuss off-label use and/or investigational use in my presentation
Medical Response to Human Spacecraft Accidents

• Accidents and Close Calls
  – Why we need to be prepared
    • U.S. Program – three accidents with fatalities
      – AS-204 - Apollo 1 Fire (Crew: 3)
      – Space Shuttle Challenger (Crew: 7)
      – Space Shuttle Columbia (Crew: 7)
    • U.S. Program – Notable close calls
      – Apollo 13
    • Russian Program – Three accidents with fatalities
      – Pressure chamber O2 fire (Crew: 1)
      – Soyuz 1 (Crew: 1)
      – Soyuz 11 (Crew:3)
Medical Response to Human Spacecraft Accidents
Medical Response to Human Spacecraft Accidents

The JSC Flight Safety Office maintains the Significant Incidents and Close Calls in Human Spaceflight graphic to provide continuing visibility of the risks inherent with space exploration and provide engineers with a summary of past experience. It is hoped this information will be used to learn from the past and make present and future missions safer.
Medical Response to Human Spacecraft Accidents

• **Ground**
  – LH2 fire after launch scrub (Shuttle)
  – Pad Booster Fire/Explosion (Soyuz)
Medical Response to Human Spacecraft Accidents

• **Ascent Incidents (27)**
  – 17 Shuttle SRB gas sealing anomalies
  – Two Shuttle main engine controllers fail at T+5 sec
  – Lightning strike
Medical Response to Human Spacecraft Accidents

- **Orbit/Trans Lunar (52)**
  - Apollo 13 $\text{O}_2$ tank explosion
  - Three medical evacuations
  - Soyuz and Progress vehicle collisions with Mir
  - 13 fire/combustion events
  - 6 EVA cut glove incidents
  - Water and cabin atmosphere contaminants
Medical Response to Human Spacecraft Accidents

• **Entry/Landing Close Calls**
  – Stuck thruster causing loss of vehicle control
  – Service/descent module separation failures
  – Ballistic reentry
  – Soyuz landing on hillsides
  – Landing rockets fail to fire results in 30 g impact
  – Parachute failures
  – Short, hard and fast Shuttle landings
  – Shuttle auxiliary power unit fire
Medical Response to Human Spacecraft Accidents
Accident Sequence of Events

- Accident occurs
- **First responders**
- NASA activates and deploys the Mishap Investigation Team (MIT)
- Accident Investigation Board
Medical Response to Human Spacecraft Accidents

• First Responders
  – NASA-trained fire and medical personnel
    • NASA firefighters
    • NASA medical
    • DoD medical
    • Local hospital
Medical Response to Human Spacecraft Accidents

- **Physicians Supporting Shuttle EMS**
  - Basic Life Support (BLS)
  - Advanced Cardiac Life Support (ACLS)
  - Advanced Trauma Life Support (ATLS)
  - Space Operations Medical Training Course (SOMSTC)
    - Space medicine
    - Shuttle toxicology
    - Shuttle ground operations
    - Convoy procedures
    - Suit removal
Medical Response to Human Spacecraft Accidents

SAR and Transportation Assets

C-130 Hercules  EC-145  UH-60 Blackhawk

Coast Guard Falcon  US Navy Ship
Accident Sequence of Events

- Contingency occurs
- First responders
- NASA activates and deploys the Mishap Investigation Team (MIT)
- Accident Investigation Board
Medical Response to Human Spacecraft Accidents

• Mishap Investigation Team
  – Activation of the MIT starts the investigation process
  – MIT Objectives
    • Gather
    • Guard
    • Preserve
    • Document
  – MIT DOES NOT INVESTIGATE THE ACCIDENT!

The NASA Authorization Act of 2005 specifies a process whereby the following NASA mishaps will be investigated by a Presidential Commission.

Specifically, “… any incident that results in the loss of (1) a Space Shuttle; (2) the ISS or its operational viability; (3) any other United States space vehicle carrying humans that is owned by the Federal Government or that is being used pursuant to a contract with the Federal Government; or (4) a crew member or passenger of any space vehicle…”

- Challenger accident – Rogers Commission
- Columbia Accident – Columbia Accident Investigation Board
Medical Response to Human Spacecraft Accidents

Presidential Investigation Commission

Tasks

• Investigate the incident
• Determine the cause
• Identify contributing factors to the cause
• Make recommendations for corrective action
• Provide additional findings or recommendations deemed important
• Prepare a report to Congress, the President, and the public
Medical Response to Human Spacecraft Accidents

First Responders

Mishap Investigation Team (MIT)

Accident Investigation Board
Medical Response to Human Spacecraft Accidents

• Primary Medical Mission Objectives
  – Receive, analyze, identify, and transport human remains to Dover AFB and Armed Forces Institute of Pathology
  – Provide assistance in the recovery effort with the Disaster Field Office at Lufkin, TX
  – Provide family Casualty Coordinators with latest recovery information
Medical Response to Human Spacecraft Accidents

• Additional Medical Mission Objectives
  – Receive, store, analyze, and transport crew escape/life support equipment to the Kennedy Space Center
  – Receive, store, and transport biological payloads to Kennedy Space Center and the Johnson Space Center
  – Provide information to local physicians about civilian medical concerns and occupational health care issues associated with spacecraft mishaps
Mishap Investigation Team (MIT)

• Purpose
  – Gather, guard, preserve, and document all evidence pertinent to the incident for which the team was activated.
  
  – It is NOT the role of the MIT to determine cause, but to act as the fact gathering arm of the Mishap Investigation Board (MIB)

  – Once activated, MIB may or may not choose to continue using the MIT as its field investigation resource.
Medical Response to Human Spacecraft Accidents

• Mishap Investigation Team Membership
  – MIT Chair
  – Astronaut Office Representative
  – Flight Surgeon
  – Orbiter Engineer/Mishap Investigator
  – Propulsion System Engineer
  – Photographer
  – DoD Det 3 Representative
  – Payload Representative
  – Safety Representative
  – Technical Writer
  – KSC Ground Ops Manager
  – Administrative Manager
Medical Response to Human Spacecraft Accidents

Mishap Investigation Team Organization

MIT Chairman

- GOM
- HSFS

Administrative Manager

Photographer

Eyewitness, Human Factors, Crew, and Environmental Group
- Flight Surgeon – Team Lead
- Astronaut Representative

Site Investigation Group
- Systems Engineer – Team Lead
- Propulsion Engineer
- Payload Engineer
Medical Response to Human Spacecraft Accidents

Mishap Investigation Team

Flight Surgeon Field Responsibilities

- Identify and interview witnesses and others with special knowledge of the mishap
- Interview the crew. Document the interview.
- Act as interface with Armed Forces Institute of Pathology (AFIP)
- Ensure appropriate fluid samples are obtained and crew exams are performed
- Acquire crew historical information
- Identify medical information to be impounded
- Research and document medical and human factors considerations
Medical Response to Human Spacecraft Accidents

- **Mishap Investigation Team**
  - [Human and Medical Factors Checklist](#)
  - Assure that AF Form 711gA or equivalent is completed for each crewmember
  - Assure that all crew clothing and emergency equipment is impounded
  - Assure that all appropriate body fluid samples are obtained and submitted for analysis
  - Obtain statements from all crewmembers
  - Assure appropriate pathological and physiological exams are completed and data impounded
  - Assure crew historical medical information is collected and impounded
  - Document rescue activities
Medical Response to Human Spacecraft Accidents

**Flight Surgeon Tasks**

- Mishap Investigation Team
- Crewmember medical support
- Surgeon is the primary contact with AFIP
- Family support thru Casualty Assistance Control Officer (CACO)
  - Render family assistance to settle personal affairs of deceased or seriously injured astronaut
    - Includes decisions concerning handling of remains, funeral arrangements, collecting death gratuities, filing for benefits and entitlements
Medical Response to Human Spacecraft Accidents

- Mishap Investigation Team
  - Human remains
    - Collection
    - Storage
    - Record Keeping
    - Transportation
    - Security
    - Identification
Medical Response to Human Spacecraft Accidents

• Mishap Investigation Team

  Tasks

• Death Certificates
  – Cause of death
  – Place of death

• Crewmember personal items
  – Chain-of-custody process
    – Required by NASA
    – NASA IG involvement
Medical Response to Human Spacecraft Accidents

- Mishap Investigation Team
- **Protocol**
  - Foreign national issues
    - Flags
    - Religious issues
Medical Response to Human Spacecraft Accidents

• Mishap Investigation Team
• Spacecraft hazardous materials
  – Notices to public
  – Treatment concerns at local hospitals
Medical Response to Human Spacecraft Accidents

FUTURE

SOYUZ  NASA  Commercial
• Soyuz
  – By agreement, Soyuz accident will be investigated by the Russian Program
  – U.S. Support for Soyuz Launch
    • U.S. Deputy Crew Surgeon with Russian SAR forces at launch site airfield
  – U.S. support for Soyuz landings contingencies
    • Crew Surgeon with medical field pack at nominal landing site
    • Deputy Crew Surgeon with medical field pack at ballistic landing site
Medical Response to Human Spacecraft Accidents

- Commercial Space Accident
  - FAA regulates
  - NTSB investigates

- Current law states a Presidential Commission will investigate: “… any incident that results in the loss of (1) a Space Shuttle; (2) the ISS or its operational viability; (3) any other United States space vehicle carrying humans that is owned by the Federal Government or that is being used pursuant to a contract with the Federal Government; or (4) a crew member or passenger of any space vehicle…”
Medical Response to Human Spacecraft Accidents

• Commercial Space Launch from a Government Launch Facility
  – CCAFS
    • USAF first responders with mutual aid from KSC?
  – KSC
    • KSC first responders with mutual aid from CCAFS?
Medical Response to Human Spacecraft Accidents

• Commercial Space Landing and Recovery
  – Water Return
    • Recovery ship medical capability?
    • Crew Surgeon on recovery ship?
    • Medical evacuation capability for injured crewmembers?
  – Land Return
    • Crew Surgeon at primary landing site with recovery personnel?
    • Medical evacuation capability for injured crewmembers?
Medical Response to Human Spacecraft Accidents

• Commercial Space Landing and Recovery
  – On-orbit Accident
    • Commercial vehicle collision with ISS
      – NTSB or Presidential Investigation?
Medical Response to Human Spacecraft Accidents

• Commercial Space Landing and Recovery
  – Will NASA utilize and deploy a Mishap Investigation Team? How will it function?
    • Victim recovery and identification
    • Cause of death
    • Family support
Medical Response to Human Spacecraft Accidents

• NASA Vehicle
  – Launch
    • Similar to Space Shuttle
  – Water Return
    • Crew Surgeon on recovery ship
    • Medical Evacuation for injured crewmembers.

– Mishap Investigation Team
  • Victim recovery and identification
  • Cause of death
  • Family support