# NASA Medical Response to Human Spacecraft Accidents

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# Disclosure Information
## *82nd Annual Scientific Meeting*

*Robert Patlach*

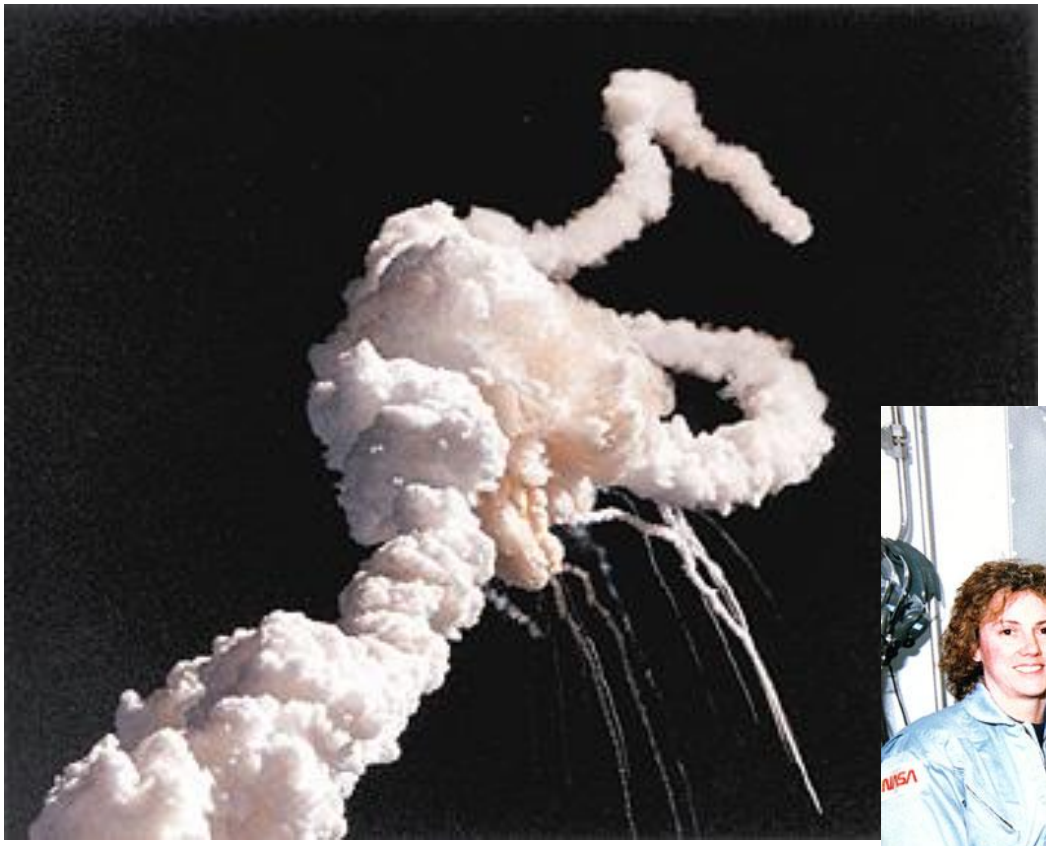
- I have no financial relationships to disclose.
- I will not discuss off-label use and/or investigational use in my presentation

# 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



# Medical Response to Human Spacecraft Accidents

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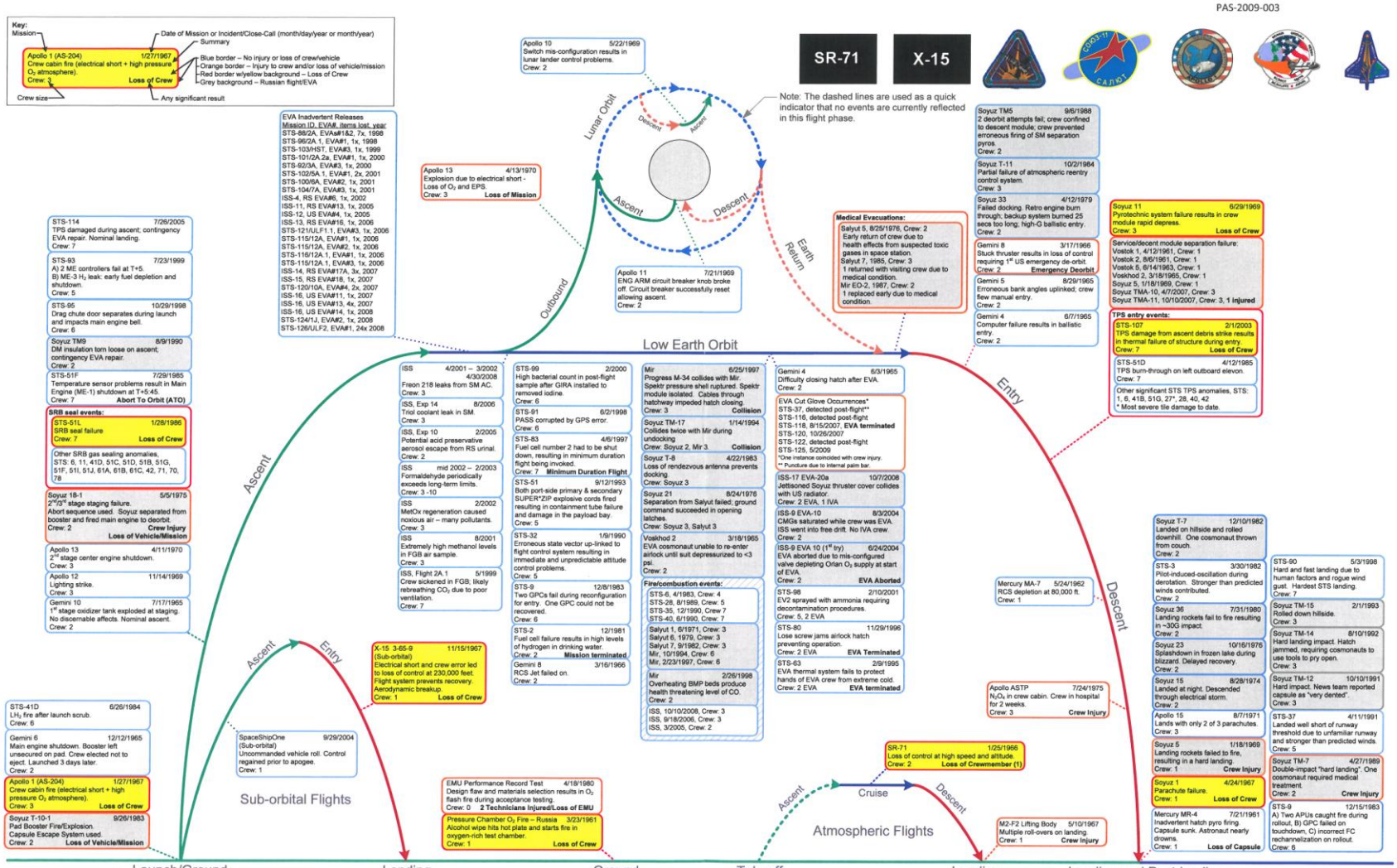


The JSC Flight Safety Office maintains the *Significant Incidents and Close Calls in Human Spaceflight* graphic to provide continuing visibility of the risks inherent with space exploration and provide engineers with a summary of past experience. It is hoped this information will be used to learn from 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 $O_2$ 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

# 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!

# Medical Response to Human Spacecraft Accidents

## Public Law 109-155, NASA Authorization Act of 2005

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

## 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)**

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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)

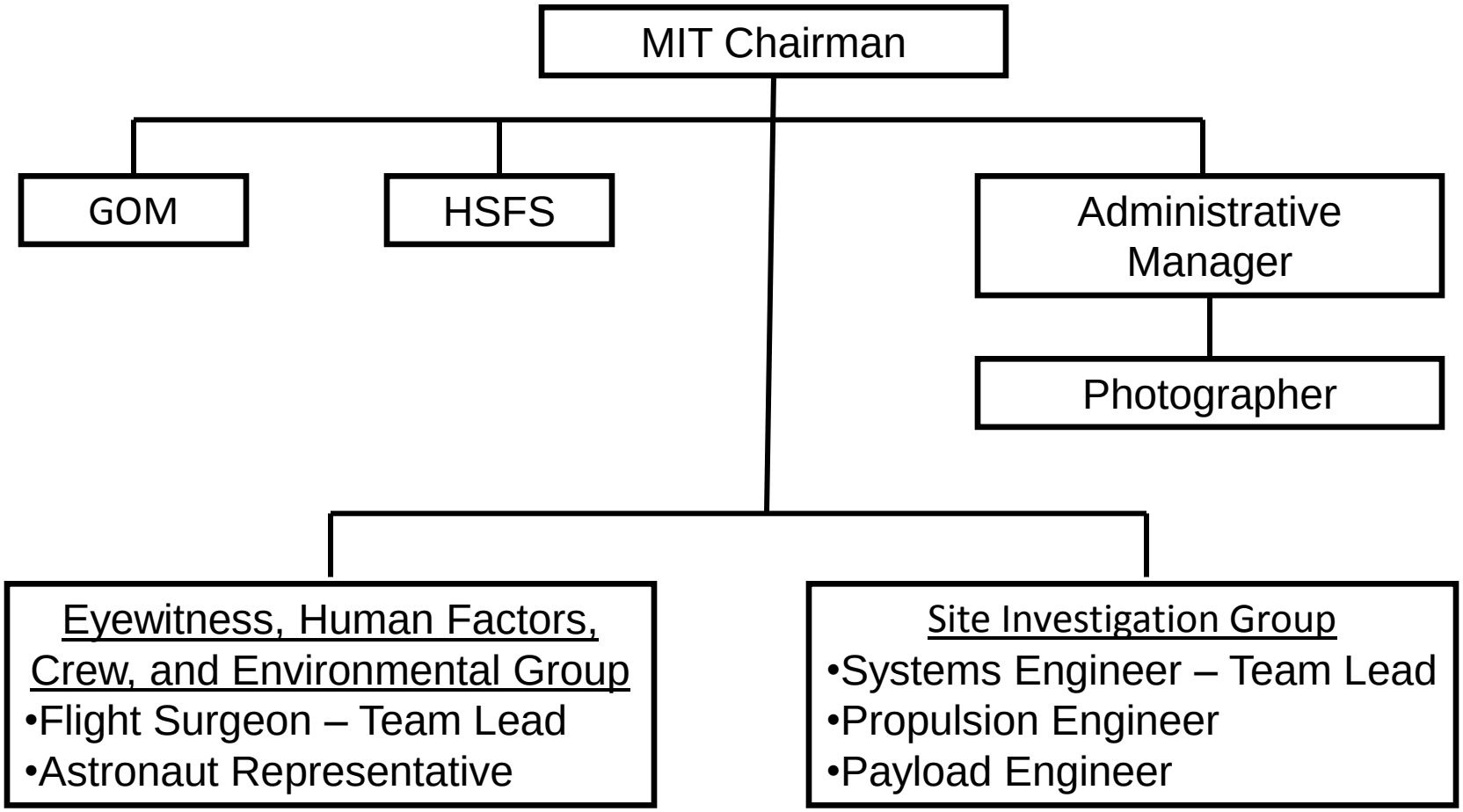
- Purpose
  - Gather, guard, preserve, and document all evidence pertinent to the incident for which the team was activated.
  - It is NOT the role of the MIT to determine cause, but to act as the fact gathering arm of the Mishap Investigation Board (MIB)
  - Once activated, MIB may or may not choose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



# Medical Response to Human Spacecraft Accidents

- Mishap Investigation Team

<u>Flight Surgeon Field Responsibilities</u>

- 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

- Mishap Investigation Team

<u>Flight Surgeon Tasks</u>

- 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

## Tasks

- Human remains
  - Collection
  - Storage
  - Record Keeping
  - Transportation
  - Security
  - Identification

# Medical Response to Human Spacecraft Accidents

- Mishap Investigation Team

<u>Tasks</u>

- 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

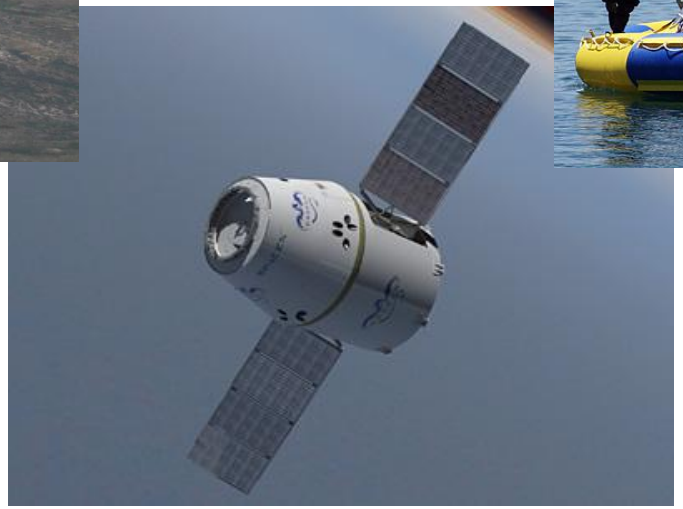
# Medical Response to Human Spacecraft Accidents

- Mishap Investigation Team
- Spacecraft hazardous materials
  - Notices to public
  - Treatment concerns at local hospitals

# Medical Response to Human Spacecraft Accidents

## FUTURE

SOYUZ



Commercial

NASA

# Medical Response to Human Spacecraft Accidents

- 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