
Introduction: With the advent of commercial spacecraft capable of repeated suborbital flight the opportunity for spaceflight participants to fly into space is increasing. The suborbital spaceflight medical environment participants will encounter has not been investigated since the early 1960’s. While the environment of suborbital spaceflight has been generally characterized, current experience has generally been limited to manned flights above or below this flight region. Participants will have a varied medical background that will affect their response to the spaceflight environment and have changing medical needs during flight operations. Many of these effects may be difficult to predict, but provide an opportunity to expand the knowledge base for future flight operations.

The medical considerations for suborbital spaceflight operations include mitigation of risks, preparedness, response, and recovery. Research into the space life sciences during flight operations will increase knowledge and safety. This creates a positive feedback loop increasing the safety margin for future spaceflight participants.

Discussion: While much has been written and discussed about the medical screening and clearance of spaceflight participants, little discussion has occurred about the continuum of care required as they flow through the flight operations. Providing medical care for participants begins prior to launch activities with preflight testing and screening to determine suitability for flight operations. Spaceflight participants will need preflight safety training, and emergency protective measures taught prior to flight operations. During flight operations support personnel will need to be available for emergency response and recovery. Biomedical and life science research will have experiment specific impacts on flight operations. Post flight recovery and return operations have additional medical implications for the returning spacefarers.

Suborbital spaceflight is considered an extreme environment, and it is the effect of this environment upon the human body that is of interest to medical providers and researchers. These environmental effects have physiologic implications for both the risk to spaceflight participants, and in the provision of care and mitigation of injuries. Some of the effects are unique to the environment, and may be difficult to predict.

Medical Risk Considerations: The selection and screening of spacefarers has been discussed in the medical literature and the FAA has developed suggested guidelines for medical professionals to use for evaluation of potential participants. [1] While government sponsored astronauts generally are held to higher medical standards, commercial spaceflight participants with significant medical problems have been cleared and successfully flown to the International Space Station without adverse medical consequences. Significant medical testing and preventative treatment were applied prior to medical clearance. [2] It should be noted that the current FAA guidelines do not require spaceflight participants to undergo a physical exam prior to flight, but the rule does require informed consent of the risks of suborbital spaceflight. [3] The rule states that safety critical flight crew must have passed an FAA second-class airman medical certificate not more than 12 months prior to the month of the launch and reentry.

The general framework of the medical risks of pre-existing medical conditions and their potential interactions with the spaceflight environment has been well described, but the actual physiological response may be different than that predicted. [4] Ongoing monitoring of spaceflight participants may be beneficial to future travelers, but may be problematic from a privacy issue unless the participants voluntarily agree or federal regulations change to require such tracking. Pre-flight identification of individuals with significant medical problems will allow for development of effective medical treatment and response capabilities.

During flight operations, the medical needs of the participants may be met through the use of dedicated trained personnel. NASA at the Kennedy Space Center...
uses a combination of NASA Flight Surgeons, and subcontractors with active experience in Emergency Medicine and Trauma Surgery to provide medical support during Space Shuttle launch and landing operations. [5] Inflight medical support is provided by a dedicated group of flight surgeons. Commercial suborbital flights with their shorter time frame will be able to condense medical support operations to a single group that can be present and active for the duration of flight activities.

Medical needs during flight operations will include emergency medical response, treatment, and evacuation capabilities. Response requirements will vary depending on the type of vehicle, location, number of participants, and failure modes. Careful planning and development of a trained medical response team will be required to provide a robust response to an adverse event.

One of the largest medical impacts inflight will come from the amount and orientation of the acceleration and gravity load on the spaceflight participant. This is a large part will be determined by the flight profile and vehicle configuration. In general, gravity loading from the head of the spaceflight participant down (+Gz or “eyeballs down”) is not tolerated as well as gravity loading front to back (+Gx or “eyeballs in”). Significant gravity loading is known to cause arrhythmia even in healthy participants. [6]

Recovery operations will include safely returning the spaceflight participants back to the operations base and ensuring that no adverse events occurred during flight operations. The medical team can monitor reduction of environmental hazards and return from the landing site. In the event of a non-nominal landing medical evaluation of the participants should be a priority.

**Summary:** Commercial suborbital spaceflight will require careful consideration to manage the medical implications of this extreme environment. Evaluation of the participants may be required and careful planning by the medical team will be needed to ensure that all flight operations are completed in a safe manner. A robust preparedness plan will need to be incorporated into flight operations. This difficult environment also provides the opportunity to evaluate and study the environmental effects on human physiology and pathophysiologic conditions.

**References:**