Medical Guidelines for Space Passengers—II

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It now appears likely that commercial entities will carry paying passengers on suborbital spaceflights in this decade. The stresses of spaceflight, the effects of microgravity, and the limited capability for medical care onboard make it advisable to develop a system of medical clearance for such space tourists. The Aerospace Medical Association, therefore, organized a Space Passenger Task Force whose first report on medical guidelines was published in 2001. That report consisted of a list of conditions that would disqualify potential passengers for relatively long orbital flights. The Task Force reconvened in 2002 to focus on less stringent medical screening appropriate for short duration suborbital flights. It was assumed that such commercial flights would involve: 1) small spacecraft carrying 4–6 passengers; 2) a cabin maintained at sea-level "shirt-sleeve" condition; 3) maximum accelerations of 2.0–4.5 G; 4) about 30 min in microgravity. The Task Force addressed specific medical problems, including space motion sickness, pregnancy, and medical conditions involving the risk of sudden incapacitation. The Task Force concluded that a medical history should be taken from potential passengers with individualized follow-up that focuses on areas of concern.

Keywords: space tourists, suborbital flight, commercial spaceflight.

BECAUSE THE COMMERCIAL SECTOR is planning to offer suborbital spaceflight to paying passengers in this decade, the Aerospace Medical Association (AsMA) convened a Space Passenger Task Force in 2001 to explore related medical concerns. The 15 members of that Task Force represented a cross section of the Association and their deliberations served as a valuable exploratory and educational forum. The report of that meeting was published in this journal (1). Consideration was given to both short-duration flights (minutes to hours) and longer flights (3–14 d). Each organ system was reviewed in that context and specific disqualifying conditions were identified for paying passengers.

Although AsMA was acknowledged by the commercial sector for taking the initiative in this area, there were requests for development of more liberal guidelines for passengers on suborbital flights of short duration. For that reason, the Task Force met again in 2002, to draft a second set of guidelines using a much different approach.

First, long-duration commercial flights will probably not be possible in this decade. Consequently, it was decided to focus only on short-duration flights lasting no more than several hours, a type of flight for which the commercial sector is now building vehicles. Second, the space vehicles being developed today by about 20 companies in several countries have varying flight profiles and characteristics—for example, some are launched like a rocket while others take off and land like conventional aircraft—imposing different physiological stresses on the space vehicle occupants. Therefore, it becomes difficult to establish specific medical guidelines applicable to every flight profile. Third, it is doubtful that there will ever be a regulatory agency that would have the authority to promulgate medical standards for space tourists or passengers flying in commercial space vehicles. (This will not necessarily be true, however, for passengers flying onboard government-sponsored vehicles such as the Shuttle, Soyuz, and the International Space Station.) More than likely, commercial interests will formulate their own medical standards based on their own profile of flight and counsel from their own medical consultants.

For these reasons, the Task Force opted to be less prescriptive. Rather, the following assumptions were formulated, and on them very general guidelines were proffered for consideration by commercial interests, physicians, and space passengers.

ASSUMPTION #1

The space vehicle interior will be small and confining with a capacity for 4–6 passengers.

Because of confinement for several hours without a

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means of escape during most of the flight, qualification of passengers with claustrophobia should be given careful consideration. Also, in a confined space there is an increased risk for person-to-person disease transmission. Consequently, passengers would be well advised to postpone flight until any infection is under control and no longer communicable.

ASSUMPTION #2

The flight will be suborbital of 1 to 3 h duration including about 30 min in microgravity.

ASSUMPTION #3

The cabin will be pressurized to sea level (760 mm Hg) with an 80% nitrogen, 20% oxygen atmosphere; no life support equipment will be necessary for nominal flight.

With a sea-level cabin pressure and atmosphere, the passenger will be in a "shirt-sleeve" environment. Hence, there should be no requirement for special life support equipment, although the quick donning of an oxygen mask may be necessary in the event of an emergency such as decompression or fumes in the cabin.

ASSUMPTION #4

Acceleration will range between 2–4.5 $+G_z$ or G_x (depending on the space vehicle).

The effects of accelerative forces, G_z and G_x, on the body are well known. Positive G_z can cause damage to bone and soft tissue, particularly of the spinal column. Although this would be unlikely at low G loads, e.g., 1.5–2. 5 $+G_z$, 100% certitude cannot be assured at loads up to 4.5 $+G_z$. Consequently, one would have to exercise caution if a patient had, for example, severe osteoporosis, significant cervical or lower spinal cord disease, or a diathesis for pathological fractures. Likewise, there is also the risk of tissue damage for an individual who has had recent surgery, particularly of the abdomen.

In addition, $+G_z$ causes pooling of the blood in dependent parts with a decreased venous return and decreased cardiac output. Although this phenomenon on the cardiovascular system is very well tolerated (even with high-G loads) by individuals in reasonably good health, this may not be true for prospective passengers with unstable angina, unstable congestive heart failure, a recent myocardial infarction, or significant coronary artery disease. Special care should also be taken for those with mechanical valves (it is not known how a mechanical valve would function under G loading) or those with a significant arrhythmia.

If the vehicle is launched like a rocket, the passengers presumably would be lying down. Consequently, accelerative forces would be through the chest or G_x axis, which is very well tolerated. Forces of 2–4.5 $+G_x$ should pose little or no danger to passengers in reasonably good health.

ASSUMPTION #5

There will be different emergency egress procedures (depending on the space vehicle).

Because emergency egress procedures will vary according to the vehicle, specific medical guidelines cannot be recommended. However, it is advised that passengers should be able to demonstrate the capability to perform required emergency egress procedures for the vehicle and should not have a condition that would either compromise this capability or impede others to safely and expeditiously egress.

OTHER CONSIDERATIONS

Other areas addressed by the Task Force included space motion sickness (SMS), pregnancy, sudden incapacitation, and age. Among astronauts, there is an 85% incidence of space motion sickness (SMS) with vomiting often occurring only minutes after launch. Therefore, a similar incidence can be expected among passengers. Although there is no known association of SMS with individuals who easily become car sick or air sick (because SMS is caused by a different mechanism), special consideration should be given to passengers who are very sensitive to motion or who have an underlying illness causing frequent vomiting.

For a prospective space passenger who is pregnant, the main theoretical concern is the possible effect of acceleration on the fetus. For obvious ethical reasons, there is nothing in the literature to allay this concern. With no scientific knowledge of the effects of $+G_z$ or $+G_x$ on pregnancy and the fact that the flight is an elective excursion, it might be best to err on the side of safety rather than sorrow by postponing the flight until after pregnancy. Postponement is particularly advised for an individual with a complicated pregnancy, for example, pain, bleeding, or history of premature delivery.

Special consideration should also be given for individuals who have unstable conditions or an underlying disposition for sudden incapacitation. This is particularly compelling because there will be little, if any, medical care capability in flight and, of course, there would be no option to land immediately. Examples of such illnesses include unstable angina or congestive heart failure, frequent unexplained syncope, uncontrolled seizures, and significant mental health illness including psychosis and a suicidal proclivity.

The Task Force members do not recommend age as a criterion for flight, but strongly recommend that every passenger, regardless of age, occupy a seat with appropriate restraints.

Because of the short duration of flight, there should be very little difficulty after landing although some passengers may experience postflight neurovestibular dysfunction such as disturbed gait and balance, and vection illusions. Likewise, there could be some degree of orthostatic intolerance and possibly even syncope, although this is improbable given the short duration in microgravity. These aberrations spontaneously correct themselves soon after returning to Earth, although physicians should be aware of them when evaluating a passenger preflight.

The Task Force recommends that medical histories be taken both at the time of flight application and then again immediately preflight. Depending on the history,

the physician should decide if a physical examination and/or diagnostic studies would be necessary. In any event, this medical evaluation, regardless of its depth and breadth, should focus on the issues as described above. Although any physician could evaluate a passenger, it would be far preferable if the examining physician had some formal training in aerospace medicine.

In summary, the 2nd Task Force on Space Travel offers only broad guidelines, rather than specifics, for short-duration flights. The application of these guidelines should be left to the discretion of the companies, physicians, and passengers. In cases of passengers with significant illness, sound medical judgment will be essential.

REFERENCE

1. Aerospace Medical Association Task Force on Space Travel. Medical guidelines for space passengers. Aviat Space Environ Med 2001; 72:948-50.