By Claud "Doc" Morgan, M.D.

Safe air show flying requires attention to general health concerns. If a pilot feels more than "just a little under the weather," flying an air show would be an unnecessary and unreasonable risk. If the decision is made to fly with a minor illness like a cold, avoid all sedative drugs like antihistamines or alcohol. These are found in many nonprescription medications. They will impair reflexes, judgment and G-tolerance.

Occasionally the performer may be faced with a minor injury — neck, back or rib strain, for instance. In this situation, the ability to move the head under G-loads or to perform an adequate anti-G maneuver will be impaired. A thoughtful decision must then be made about whether to fly the show or modify the routine.

Anxiety and stress are natural and normal aspects of air show flying. They cause a state of enhanced alertness which results in a well-flown, safe flight.

But anxiety and stress are dangerous factors when too severe. The overly-anxious performer will often hyperventilate during the flight. Hyperventilation results in exhaling too much carbon dioxide, which raises the pH (measure of acidity) of the blood to an abnormal level. The effect on the brain quickly results in impaired judgment and any combination of numerous physical symptoms — dry mouth, light-headedness, tingling in the hands or feet, tightness in the throat and nausea. Adequate blood flow is necessary to supply sufficient oxygen and glucose to meet the brain's metabolic demands. Because blood flow to the brain is reduced with hyperventilation, G-tolerance is also reduced.

Preoccupation with other duties at the air show or with personal problems will interfere with the concentration needed to fly a good show. This is especially important to keep in mind for those who wear several hats at an event. When possible, nonflying duties should be delegated.

The performer who is tired from the late night before or who has even a mild hangover will not fly as well as or as safely as normal. To some degree, judgment and concentration will be impaired, reflexes slowed and G-tolerance reduced.

Negative G-stress is generally well tolerated and without major consequences. Positive G-stress (G-tolerance), on the other hand, may lead to serious problems. These symptoms have been reported:
* Loss of consciousness
* Greyout
* Blackout
* Convulsions
* Reduced cardiac output
* Heart rhythm disturbances
* Displaced or dislodged contact lenses
G-time tolerance curve for an average person seated upright, relaxed and employing no means of protection against effects of G. The environment in which visual symptoms and G-induced loss of consciousness (GLC) occur is pictorially described in terms of +Gs force applied and time of application of that G force.

Effect of G-onset rate on symptoms at G stress experienced. Gradually applied +Gs force results in several seconds of visual symptoms occurring before GLC occurs, whereas G stress rapidly applied and then sustained at a high level can result in GLC without any preceding visual symptoms.

* Various neck injuries
* Muscle and ligament strain
* Fractures
* Herniated discs

Obviously, the most important of these to avoid is G-loss of consciousness (GLC). The average period of GLC is 15 seconds. It is typically followed by a period of confusion and reduced psychomotor function of up to one minute. Clearly, this event would be lethal in the air show environment and must be avoided at all costs. To facilitate the best understanding of the basic physiology of G-tolerance.

With positive G-stress, blood drains from head to toe, starving the brain of adequate oxygenation. The first symptom is greyout because color vision is lost. Blackout occurs immediately afterward, resulting in complete blindness. GLC follows very quickly after that.

A reflex in the blood vessels, called the baroceptor reflex, becomes operative after the onset of the G-load. This reflex causes the blood vessels in the lower part of the body to progressively constrict to inhibit this flow of blood away from the brain.

It takes about five to six seconds for blood to drain out of the head even with very high G-loads. For that reason, no one will suffer GLC if the G-load is pulled for five seconds or less. After five or six seconds of a heavy G-load, however, GLC will occur unless the pilot either reduces it or performs an effective anti-G maneuver (Figure 1).

Rapid onset of sustained high G-loads will result in the shortening or even the elimination of the greyout/blackout warning period, as shown in Figure 2. A similar situation may occur when going directly from negative G to positive G.

The factors listed below will reduce G-tolerance, thus shifting the curves in Figures 1 and 2 down and to the left. They do this primarily by slowing and weakening the baroceptor reflex. Other reasons are involved as noted:

* Illness
* Fatigue
* Hypoglycemia (low blood sugar)
* Alcohol
* Hangover
* Medications
* Heat stress (reduced cardiac output)
* Cold stress
* Dehydration (reduced volume in blood vessels causes reduced cardiac output)
* Hyperventilation (cerebral vasoconstriction)
* High-level aerobic conditioning, such as running 15 - 20 miles per week or resulting in a resting pulse (less than 55)
* Higher altitudes (relative hypoxia resulting in reduced oxygen to the brain, especially when there has been little time to acclimate)
These are factors which increase G-tolerance:
* Anti-G training maneuver
* Strength (anerobic) training
* Moderate aerobic conditioning
* Frequent exposure to G-stress

The single most important factor in improving G-tolerance is the anti-G training maneuver. The one currently used by most of the world’s fighter pilots is called the L-1.

The L-1 has been shown to increase G-tolerance by up to 3 G’s when properly performed (Figure 3).

L-1 is performed by 3-second grunts (without letting any air out) alternating with 0.5-second breaths (exhale and inhale quickly) while simultaneously tensing all the muscles in the body. This exercise should be practiced and employed by any pilot who flies air shows. Even if the G-load will be experienced for less than five seconds, the L-1 will greatly inhibit the flow of blood from the brain so that it can function at its maximum capacity.

Strength training makes the L-1 maneuver much more effective. Aerobic conditioning allows the pilot the stamina to repetitively perform effective L-1 maneuvers throughout the routine without undue fatigue.

Frequent exposure to G-stress results in a more effective baroreceptor reflex.

These 12 recommendations summarize the do’s and don’ts of safe air show flying:
* Avoid flying when feeling ill, upset or under undue stress.
* Avoid all medications not approved by a flight surgeon.
* Be well rested.
* Eat three balanced meals daily to avoid hypoglycemia.
* Drink extra fluid and increase dietary salt on hot days.
* Dress for the weather.
* Don’t fly with a hangover.
* Avoid hyperventilation during flight.
* Beware the reduced G-tolerance of higher altitudes.
* Maintain moderate aerobic conditioning.
* Maintain some program of strength training.
* Perfect a good L-1 maneuver and use it.