Aviation Medicine Seminar Series

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(1) How to Ace the Medical Exam
December 13, 2003

- AME training
- How to find a Medical Examiner
- What the exam involves
- The 15 disqualifying conditions…
Aviation Medicine Seminar Series

(2) Spatial Disorientation-January 10, 2004
- **Vestibular** based disorientation: What it is, How to deal with it
- **Vision** based disorientation: What it is, How to deal with it
(3) Common Aeromedical Problems-
  • February 14, 2004
  - Motion Sickness
  - Hyperventilation
  - Hypoxia (March 13, 2004)
  - Carbon Monoxide
  - Trapped gas
(4) Advanced Topics

March 13, 2004

- Self imposed stress
- Hypoxia/Oxygen use and abuse
- Altitude induced decompression sickness
- Trapped gas
- Cabin pressurization
Accidents by Primary Cause*

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Crew</td>
<td>98</td>
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<tr>
<td>Airplane</td>
<td>21</td>
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<tr>
<td>Weather</td>
<td>14</td>
</tr>
<tr>
<td>Misc./Other</td>
<td>8</td>
</tr>
<tr>
<td>Maintenance</td>
<td>4</td>
</tr>
<tr>
<td>Airport/ATC</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total with known causes</strong></td>
<td><strong>149</strong></td>
</tr>
<tr>
<td><strong>Unknown or awaiting reports</strong></td>
<td><strong>61</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>210</strong></td>
</tr>
</tbody>
</table>

*As determined by the investigating authority
Major causes of incapacitation by age

<table>
<thead>
<tr>
<th>Age Groups (Years)</th>
<th>LOC</th>
<th>Cardiac</th>
<th>Neurological</th>
<th>GI</th>
<th>Urological</th>
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<tbody>
<tr>
<td>25-29</td>
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<td>35-39</td>
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<td>45-49</td>
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<tr>
<td>55-59</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Frequency
Fit For Flight

Introduction

• There is value in having a lifestyle that includes proper exercise

• It positively affects all aspects of your life while at the same time benefiting you as an aviator
Fit For Flight

Introduction

• With a proper physical fitness program you will find you have more energy and stamina whether on the ground or airborne

• You will have the ability to withstand fatigue while improving cockpit management and situational awareness
Fit For Flight

Introduction

• Before starting any fitness program it is recommended to see a Physician

• An exercise physiologist or professional trainer can help you personalize a specific fitness program
Graham’s Law: An area of high pressure exerts force toward an area of low pressure.

Respiration: The act of an organism exchanging gases with its environment.

Circulation: The continuous and repetitive movement of blood through the various vessels of the body.

Purpose: To supply the cells of the body oxygen (O2) and remove the carbon dioxide (CO2) produced by cellular activities.
Places O2/CO2 Are Exchanged in the Body

- External respiration - atmosphere / lungs
- Internal respiration - lungs / blood
- Cellular respiration - blood / body cells
External Respiration

- THE TRACHEA
- NASAL PASSAGE
- BRONCHI
- BRONCHIOLE
- ALVEOLAR DUCT
- ALVEOLI (AIR SACS)
Partial Pressures of Gases

Nitrogen - 573mm/hg
Oxygen - 100-102mm/hg
Carbon Dioxide - 40mm/hg
Water Vapor - 47mm/hg

96-98% O2 = SEA LEVEL = 760mm/hg

BLOOD SATURATION
ALVEOLUS

$\text{pO}_2 = 100\text{mm}$

$\text{pCO}_2 = 40\text{mm}$

$pCO_2 = 46\text{mm}$

$pO_2 = 40\text{mm}$

$pO_2 = 100\text{mm}$

Internal respiration
The continuous and repetitive movement of blood through the various vessels of the body.
Cellular Respiration

FROM THE LUNGS

pCO₂ = 46mm
pO₂ = 1 to 60mm

TISSUE CELL

TO THE LUNGS

pCO₂ = 46mm
pO₂ = (100mm to 40mm)
Respiration & Circulation

Cellular Respiration (continued)

• Partial pressure of carbon dioxide in the cells is higher than the partial pressure of carbon dioxide in the blood
  - Carbon Dioxide is off-loaded to the blood
O2 BLOOD SATURATION

96-98% = SEA LEVEL = 760mm/hg

72% = 18,000 = 380mm/hg

9% = 25,000 = 283mm/hg
"Shhhh, Zog! ... Here come one now!"
HYPOXIA

Term refers to the absence of an adequate supply of oxygen to the tissues, whether in quantity or molecular concentration.

INSIDIOUS NATURE
TYPES OF HYPOXIA

Hypoxic hypoxia: (lung level) ALTITUDE HYPOXIA

Stagnant/Circulatory hypoxia: (transport level) G FORCES

Hypemic hypoxia: (blood level) CARBON MONOXIDE

Histotoxic hypoxia: (cell level) ALCOHOL
Hypoxic hypoxia:

(lung level)
Stagnant/Circulatory hypoxia:
(transport level)

POSITIVE G FORCE
Hypemic hypoxia:
(blood level)

SMOKE & FUMES

CARBON MONOXIDE

ANEMIA, GIVING BLOOD, SMOKING
Histotoxic hypoxia:
(cell level)

ALCOHOL

DRUGS, CYANIDE, CARBON MONOXIDE
CAUSES OF HYPOXIA IN FLIGHT

- Ascent to altitude without supplementary Oxygen
- Aircraft decompression at altitude
- Pilot does not know how to operate equipment
- Failure of oxygen supply equipment
Hyperventilation

*Introduction*

Breathing is an automatic body function that we take for granted. It is the process of taking air into the lungs and exchanging gases with our environment.

Carbon dioxide is the gas produced by all living cells of the body as a waste product.
Hyperventilation

Introduction

Carbon dioxide has a very important role in maintaining chemical balance in the body and controlling breathing.

Excess carbon dioxide is eliminated by the lungs during exhalation.
Hyperventilation

Introduction

• Some carbon dioxide must remain in the body for the proper pH balance of the blood

• The concentration of this gas in the body is monitored closely by the brain
Hyperventilation

Control of Breathing

The average adult breathing cycle is 12 - 16 breaths per minute
- Directly correlates to amount of carbon dioxide in blood

Breathing rate can be stimulated or slowed down through voluntary muscle control
Hyperventilation
Control of Breathing

- When exposed to situations of emotional stress, fright, or pain our body usually by breathing faster than normal.

- This reaction is known as hyperventilation
Hyperventilation

*Cause and Effects*

- Hyperventilation is a condition where the rate and depth of breathing is abnormally increased.
- This causes an excessive loss of carbon dioxide from the body causing a chemical imbalance in the blood.
ALVEOLUS

\[ pO_2 = 100\text{mm} \]
\[ pCO_2 = 40\text{mm} \]

Internal respiration

\[ pCO_2 = 46\text{mm} \]
\[ pO_2 = 40\text{mm} \]

\[ pCO_2 = 40\text{mm} \]
\[ pO_2 = 100\text{mm} \]
The brain defends itself against this involuntary imbalance by restricting it’s blood flow

This restriction of blood flow to the brain will cause individuals to experience symptoms that could jeopardize safety
Hyperventilation

Cause and Effects

The main cause of hyperventilation in a pilot is an emotional reaction

- Anxiety
- Fear
- Anger
- Stress
Hyperventilation

Similarity with Hypoxia Symptoms

• Because of the restricted blood flow to the brain associated with hyperventilation, it can produce symptoms that are similar to those of hypoxia.
**Hyperventilation**

*Similarity with Hypoxia Symptoms*

- Symptoms that occur with both hypoxia and hyperventilation

<table>
<thead>
<tr>
<th>Hyperventilation</th>
<th>Hypoxia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dizziness</td>
<td>Dizziness</td>
</tr>
<tr>
<td>Light headed</td>
<td>Light headed</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>Blurred vision</td>
</tr>
<tr>
<td>Numbness</td>
<td>Numbness</td>
</tr>
<tr>
<td>Tingling</td>
<td>Tingling</td>
</tr>
<tr>
<td>Muscle incoordination</td>
<td>Muscle incoordination</td>
</tr>
</tbody>
</table>
Hyperventilation

How to Differentiate

To help differentiate between hypoxia and hyperventilation monitor these elements:

- Flight altitude
- Cabin altitude
- Oxygen system
- Emotional state
- Flight environment
Hyperventilation

Distinguishable Symptoms

- Distinguishable differences between hypoxia and hyperventilation symptoms

<table>
<thead>
<tr>
<th>Hyperventilation</th>
<th>Hypoxia</th>
</tr>
</thead>
<tbody>
<tr>
<td>The onset of symptoms occurs <strong>gradually</strong></td>
<td>Hypoxia symptoms occur rapidly</td>
</tr>
<tr>
<td>Muscle activity <strong>spastic</strong> especially is upper extremities</td>
<td>Muscle soft and limp with little activity</td>
</tr>
<tr>
<td>Causes skin to appear <strong>pale and clammy</strong></td>
<td>Skin may appear blue (cyanotic)</td>
</tr>
</tbody>
</table>
Hyperventilation

Prevention

- The key to preventing hyperventilation is early recognition of signs and symptoms
- Monitor rate and depth of breathing
- Recognize stressors that would cause you to over-breathe
Hyperventilation

In-flight Treatment

- Don your oxygen mask
- Check that the oxygen regulator is on
- Ensure 100% oxygen is being delivered
Hyperventilation

In-flight Treatment

- Make sure that all connections are secured
- Slow down rate and depth of breathing
- Descend to an altitude where hypoxia is unlikely to occur
Incapacitations

- 1997 PA-28 accident, the passenger reported pilot incapacitation before she also lost consciousness. Investigation revealed a hole due to corrosion approximately 1 1/2 in. by 5 in. thus allowing exhaust into the aircraft.

- The 71 year old mother/passenger was a pilot, but not familiar with that aircraft. Fuel ran out, crash ensued.

- Detector technologies

- Tox results:
  - Mother 69% COHg
  - Son 43% lung tissue
  - 25% heart tissue
Carbon Monoxide

- Odorless
- Colorless
- Tasteless

- Usually the by product of combustion engines…if you smell engine fumes it’s there
Carbon Monoxide - Causes

- Often a leak of gases between the engine exhaust and cabin heating systems. Could also be smoke inhalation (if plastics are burning, cyanide could be released)

- CO has a 200 fold greater affinity for hemoglobin than O2…once it’s on it’s hard to get off
Carbon Monoxide - Symptoms

- Sluggishness - Confusion
- Visual disturbances
- Tightness across the forehead - Headache
- Throbbing and/or pressure at the temples
- Ringing in the ears
- Severe headache - nausea - dimming of vision - seizures - unconsciousness - death
Carbon Monoxide - Prevention

- Maintenance of heating system
- Carbon Monoxide Detector
- Be aware of Symptoms
- Be knowledgeable in treatment
Carbon Monoxide - Treatment

- Shut off cabin heater
- Open fresh air source immediately
- Use 100% oxygen if available
- Land as soon as possible
- Correct source of problem before further flight

*Even symptoms of mild CO poisoning might take minutes to hours to resolve*
Gases within the body are governed by physical and chemical laws that describe how a volume of gas changes in response to changes in pressure and temperature (Boyle’s Law).

Body cavities each have openings that allow the gas to enter or exit.
Trapped Gas

Intro to Trapped Gas

- Problems arise when these openings are reduced in size or closed, the gas is then considered trapped.

- Gas expansion occurs within the natural gas cavities of the body that contains varying amounts of gas.
Trapped Gas

Intro to Trapped Gas

- Gas cavities
  - Middle Ear
  - Sinuses
  - Stomach and Intestines
  - Teeth
Trapped Gas

Ascending Phase

During the ascending phase of flight you are more likely to develop problems with the gastrointestinal tract, and on rare occasions, the teeth.
Trapped Gas
*Ascending Phase*

**Gastrointestinal Tract**

- Relieve by burping and passing gas
- Pilots should watch their diet and avoid foods that cause excess gas formation
- If you encounter any abdominal pain on ascent you should
  a. Treat as soon as the symptoms appear
  b. Relieve internal pressure by belching or passing gas
  c. Massage affected area
  d. Descend
Trapped Gas
Ascending Phase

• With advances in modern dentistry, problems with trapped gas in the teeth are rare
Trapped Gas

Ascending Phase

Teeth

- Dental problems that can cause pain on ascent
  a. A cavity
  b. Bad dental work
  c. An abscess
  d. Swollen maxillary sinus from impacted wisdom tooth

- Treatment
  a. Land and see your dentist
  b. Maintain a schedule of good dental hygiene
FILLING
PULP CAVITY
DECAY
RECEDING GUM
ABSCESS

ASCENT

Teeth
Gastrointestinal Tract
DON’T hold your breath on ascent
Descending Phase

- During the descending phase you are more likely to develop problems in the middle ear and sinuses.
- During descent as ambient pressure increases, air must forcibly enter the middle ear through the eustachian tube.
Trapped Gas

Descending Phase

Middle Ear

- Normal ear clearing accomplished by
  a. Swallowing
  b. Exaggerated jaw movement
- Upper respiratory infections may cause the eustachian tube to become blocked
- Middle ear block symptoms
  a. Sensation of fullness
  b. Minor hearing loss
  c. Discomfort
  d. Ringing in the ears
Trapped Gas

Descending Phase

Middle Ear
- Middle ear block symptoms (continued)
  e. Pain
  f. Dizziness
  g. Nausea
  h. Eardrum rupture
- Middle ear block treatment
  a. Yawning
  b. Swallowing
  c. Chewing
  d. Perform a Valsalva
  e. Climb
Trapped Gas

Descending Phase

- Sinuses blockage can occur on ascent or descent, however, problems are more likely to occur on descent.

- The most commonly affected sinuses are the frontal and maxillaries.
Trapped Gas

Descending Phase

- Sensation of fullness may or may not appear before the onset of pain

- Onset rate can occur faster than middle ear problems and can be incapacitating
Trapped Gas

Descending Phase

- **Sinuses**
  - Sinus block treatment
    a. Level off from descent
    b. Perform a Valsalva maneuver
    c. Gradual descent
    d. Stair step down
Motion Sickness

Introduction

Anytime you are exposed to an environment that is characterized by unfamiliar motion and orientation cues you are potentially subject to motion sickness.

This is normal response and can occur in a variety of situations.
Motion Sickness

Introduction

• Motion sickness is uncommon among experienced pilots, but, is more common with student pilots and passengers

• Motion sickness can progress to a stage where it can become completely incapacitating
Motion Sickness

Signs and Symptoms

- Increased salivation and swallowing
- Stomach awareness
- Nausea
- Vomiting
Motion Sickness

Signs and Symptoms

- Cold sweat
- Apathy
- Drowsiness
- Increased Yawning
Motion Sickness

Signs and Symptoms

- Headache
- Dizziness
Motion Sickness

Progressive Stages

• Desire for food is lost
• Saliva collects
• Perspiration begins
• Nausea and disorientation
Motion Sickness

*Progressive Stages*

- Headache
- A tendency to vomit
Motion Sickness

Factors That Increase Susceptibility

• Fatigue
• Alcohol
• Drugs
• Medications
Motion Sickness

Factors That Increase Susceptibility

• Stress
• Illness
• Anxiety and fear
• Insecurity
Pilots who are susceptible to motion sickness should not take any prescription or over-the-counter medications that eliminate motion sickness

- Medications can cause extreme drowsiness
- Research has shown motion sickness medications can cause temporary deterioration of navigational skills and can hamper other task that demand keen judgment
Motion Sickness

Methods to Decrease Susceptibility

• Increase exposure to flying conditions

• Pilots who keep their mental focus on the task of flying are less likely to be affected
Motion Sickness

Methods to Control Motion Sickness

- Open the air vents
- Loosen tight fitting clothing
- Use supplemental oxygen
- Focus on a point outside the aircraft
Motion Sickness

Methods to Control Motion Sickness

- Place head against the seats headrest
- Avoid unnecessary head movement
- Cancel flight and land
Motion Sickness
Complementary Approaches

- MH6/P6
  - Sea-bands®
  - ReliefBand®
  - AcuDisc®
Self Imposed Stress

Introduction

Definition of Stress

- Stress is the sum of biological reactions to any adverse stimulus - be it physical, mental, emotional, internal or external - that tend to disturb the “Body’s Natural Balance”

Although difficult to determine the full effect of stress on the pilot, it is important to be aware of the stresses we can control.
Self Imposed Stress

Introduction

- Self imposed stresses have adverse effects on pilots and therefore can affect the safety of flight
- Each stress can deteriorate your piloting skills and these stresses are cumulative
Self Imposed Stress

Self Imposed Stresses

- Alcohol consumption
- Self medication
- Drug use
- Tobacco use
Self Imposed Stress

Self Imposed Stresses

- Inadequate diet and nutrition
- Psychological stress
- Fatigue
- Poor physical fitness
Self Imposed Stress

Alcohol

- Alcohol is a depressant, hypnotic, and addicting drug that in any quantity will have adverse effects on your flying ability
Alcohol and the FARs

■ FAR 91.17

❖ No person may operate or attempt to operate an aircraft:
  ✦ within 8 hours of consuming alcohol
    • within 24 hours if intoxication or IFR flying is involved (recommendation only)
  ✦ while under the influence of alcohol
  ✦ with a blood-alcohol content of 0.04% or greater
Alcohol as a Drug

- Alcohol is a drug
  - Depressant
    - Blocks impulses from the brain and decreases the ability of the brain to use oxygen
    - Majority of adverse effects are to brain, eyes and middle ear: Crucial organs for pilots
Effects of Alcohol

- Alcohol:
  - slows reaction time
  - impairs judgement
  - impairs memory
  - impairs vision
  - impairs hearing
  - increases fatigue
  - synergistic effects with medications
BAC and Impairment

- **0.02% - 0.07%**: significant performance decrements
- **0.04%**: markedly impaired performance (3 standard alcoholic drinks for the average person)
# Elimination of Alcohol

Approximately 1/3 oz/hour

<table>
<thead>
<tr>
<th>Number of Drinks</th>
<th>Hours to Clear Alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer</td>
<td>2</td>
</tr>
<tr>
<td>Cocktail</td>
<td>3</td>
</tr>
<tr>
<td>Double Martini</td>
<td>4</td>
</tr>
<tr>
<td>Cocktail</td>
<td>5</td>
</tr>
<tr>
<td>Martini</td>
<td>6</td>
</tr>
</tbody>
</table>

The graph shows the time it takes to clear alcohol from the body based on the type of drink. The data points are marked for each type of drink.
Hangover Effects

- After acute effects of alcohol intoxication
- May last up to 48-72 hours after drinking alcohol
- May be just as dangerous as intoxication itself
- Includes: impaired judgement, fatigue, irritability, headache, dizziness, dry mouth, stuffy nose, upset stomach, sensitivity to light.
Alcohol and Aircraft Accidents

- Approximately 6 to 9% of GA accidents are caused by alcohol each year.
- 0.04% (40mg/dl) FAA limit.
- 0.02% (20mg/dl) detectable & reported by CAMI.
Self Imposed Stress

Alcohol

- Impairments In;
  - Reaction time
  - Reasoning
  - Judgment
  - Memory
  - Brain oxygen utilization
    a. Hypemic Hypoxia
Self Imposed Stress

Alcohol

Visual Impairments
- Eye muscle imbalance
- Double vision
- Difficulty in focusing

Inner Ear Effects
- Dizziness
- Decreased hearing
Self Imposed Stress

Alcohol

Our body is capable of eliminating one third of an ounce of alcohol an hour.

The after effects of alcohol consumption:
- Headache
- Dizziness
- Dry mouth
- Stuffy nose
Self Imposed Stress

Alcohol

The after effects of alcohol consumption
- Fatigue
- Upset stomach
- Irritability
- Impaired judgment
- Increased sensitivity to bright light
The use of alcohol and drugs is regulated FAR 91.17

- Persons may not operate, or attempt to operate, an aircraft when they are currently under the influence of alcohol
- Have consumed alcohol within the past 8 hours
Self Imposed Stress

Alcohol

• The use of alcohol and drugs is regulated FAR 91.17
  - Have a blood alcohol content of .04% or greater
  - Are using any drug that adversely affects flight
Self Imposed Stress

*Over-The-Counter Medications*

- You should be aware that over-the-counter medications as well as prescription medications can affect the safe operation of your aircraft.
Self Imposed Stress

Over-The-Counter Medications

- Some drugs effects can be intensified when taken to altitude
- Consult your local Aviation Medical Examiner that a medication might have on you as a pilot
Self Imposed Stress

*Over-The-Counter Medications*

Antihistamine Side Effects

- Drowsiness
- Impaired coordination
- Blurred Vision

Remember that the condition you are treating may be as disqualifying as the medication you are taking
Self Imposed Stress

Tobacco

Harmful Substances associated with tobacco use

- Carbon Monoxide
- Tar
- Nicotine
Self Imposed Stress

_Tobacco_

- **Carbon Monoxide**
  - Constitutes up to 2.5% of cigarette smoke
  - Carbon monoxide combines with hemoglobin 250 times faster than oxygen
  - Brings about Hypemic Hypoxia
Self Imposed Stress

*Tobacco*

- Tar
  - Viscous residue left from tobacco smoke
  - Destroys the mucus membranes of the respiratory tract
  - Impairs proper oxygenation of the blood and reduces tolerance to hypoxia
Self Imposed Stress

Tobacco

- **Nicotine**
  - Has a narcotic effect primarily on nerve and muscle tissue
  - The amount of nicotine found in 2 cigarettes if injected into the blood stream, could be fatal
Self Imposed Stress

*Diet*

Practicing good nutrition and having proper eating habits are important in the aviation environment.

3 balanced meals a day are recommended.
Self Imposed Stress

Diet

• A balanced meal consist of
  - Carbohydrates (50-55%)
    a. Breaks down to glucose
  - Proteins (15-20%)
    a. Basic building block of all cells
  - Fats (30%)
    a. Concentrated source of energy
Hypoglycemia (Low Blood Sugars)
- Weakness
- Headache
- Irritability
- Nervousness
- Trembling
- Fainting
Self Imposed Stress

Psychological Stress

• Psychological stresses involve physiological mental, and emotional responses to sociocultural, family and job related situations
Self Imposed Stress

Psychological Stress

Personal life changes that cause stress

- Death of a spouse
- Divorce
- Moving or changing jobs
- Marriage
- Being fired
- Changes in health
Self Imposed Stress

*Flying as a Stress*

Examples of flying events that can be a direct cause of stress
- Flying in bad weather
- Night operations
- Performing an instrument approach to minimums
- Flying in high density traffic area
- Flying in to unfamiliar airports
Self Imposed Stress

*Flying as a Stress*

Examples of flying events that can be a direct cause of stress

- Becoming temporarily lost in flight
- Equipment malfunctions
- Conflicts with other crew members or ATC
- Being subject to flight checks
Self Imposed Stress

Signs and Symptoms of Stress

• Anxiety
• Irritability
• Impulsiveness
• Aggressiveness
Self Imposed Stress

*Signs and Symptoms of Stress*

- Emotional or physical isolation
- Problems concentrating
- Confusion
- Difficulty remembering important things
Self Imposed Stress

Signs and Symptoms of Stress

- Increased self doubt
- Nightmares
- Trembling
- Weakness
Self Imposed Stress

Signs and Symptoms of Stress

- Diarrhea
- Indigestion
- Frequent urination
- Migraines
Self Imposed Stress

Signs and Symptoms of Stress

- Grinding teeth
- Cold sweat
- Increased smoking or over-eating
- Alcohol and drug use or abuse
Self Imposed Stress

*How To Deal with Stress*

- Define the source of stress
- Evaluate available resources
- Explore possible solutions
- Take action
Self Imposed Stress

*How To Deal with Stress*

- Evaluate outcome
- Make corrections or changes
- Try again
Aviation Medicine Seminar Series

(4) Advanced Topics
March 13, 2004

- Hypoxia/Oxygen use and abuse
- Altitude induced decompression sickness
- Trapped gas
- Cabin pressurization