INTRODUCTION

There are many significant internal medicine problems in aerospace medicine. Although discussing them all is beyond the scope of this chapter, the following topics have been selected because of their particular importance or frequency in aviation medicine. The emphasis will be on aeromedical significance, evaluation, and disposition rather than general medical diagnosis and treatment. This emphasis highlights aerospace medicine as preventive medicine--focusing on the preclinical detection of many problems, such as coronary artery disease, hypertension, and diabetes mellitus rather than the management of clinical disease. The key aeromedical issue in all of these problems is assessing the potential for sudden incapacitation in flight. The following issues will be discussed:

a. Asymptomatic coronary artery disease  
b. Valvular heart disease  
c. Hypertrophic cardiomyopathy  
d. Dysrhythmias  
e. Hypertension intolerance  
f. Diabetes mellitus and glucose  
g. Hyperlipidemia  
h. Chronic obstructive pulmonary disease  
i. Reactive airway disease  
j. Sarcoidosis  
k. Peptic disorders  
l. Renal stones  
m. Neoplasms

Initial evaluation of all these problems is performed by the base-level flight surgeon and appropriate consultants. Definitive aeromedical evaluation of most complex or questionable medical problems is performed at the Aerospace Medicine Consultation Service at Brooks AFB, TX. After extensive evaluation of the aviator, an aeromedical recommendation is made to the appropriate waiver authority.

CARDIOVASCULAR PROBLEMS

Asymptomatic Coronary Artery Disease (CAD)

CAD is a common problem in the US, affecting an estimated five million Americans. There are 650,000 CAD deaths and 700,000 MI’s per year. Forty to 50% of people with CAD present as MI or sudden cardiac death.
Risk factors for CAD are male gender, hyperlipidemia, hypertension, cigarette smoking, diabetes mellitus and family history of premature CAD.

How important is it to diagnose asymptomatic coronary artery disease in aviators? This is an essential aeromedical issue. The diagnosis is important because disease presentation—acute myocardial infarction, severe angina, dysrhythmias, sudden death—can be suddenly incapacitating in flight. Also, in high-performance jet aircraft, the increased cardiovascular stress affects coronary artery blood flow due to rapid onset and sustained high +Gz, rendering minimal asymptomatic disease more significant.

The difficulty is how to diagnose asymptomatic CAD in the USAF aviator population with low (5%) disease prevalence. Because of this low prevalence, the positive predictive value of the current screening tests for CAD is low: exercise tolerance testing (ETT)—35%, thallium-201 scanning—less than 50%, and multiple gated acquisition (MUGA) scanning—less than 25%.

USAF aviators are generally referred for cardiac evaluations at the ACS because of abnormalities on local non-invasive cardiac testing, with or without symptoms. The following are the noninvasive tests performed at the Aerospace Medicine Consultation Service:

a. **Exercise tolerance testing** is done with the threshold for a positive test being 1mm or more depression of the ST segment below baseline at 0.08 sec from the J point. A depression of 0.5-0.9mm is considered a borderline test.

b. **Cardiac fluoroscopy**, when positive for coronary artery calcification, increases the likelihood of a positive catheterization. According to a series at the Aerospace Medicine Consultation Service, 70% of aviators with positive fluoroscopy will have measurable disease.

c. **Myocardial perfusion studies**, using the potassium analog thallium-201, when coupled with exercise are useful in identifying areas of infarction and ischemia.

d. **Echocardiography**, using the M-mode and two-dimensional techniques, assesses chamber and valve anatomy and motion. Segmental wall motion abnormalities suggest the possibility of ischemia or infarction. Furthermore, when coupled with Doppler recording, information can be obtained about the velocity, direction, amplitude, timing and character (laminar or turbulent) of blood flow, and valvular regurgitation and stenosis can be identified.

e. **Twenty-four hour electrocardiograms** are obtained using a Holter monitor to evaluate cardiac rhythm under normal activity conditions.

**Cardiac catheterization** remains the gold standard for evaluation of asymptomatic coronary artery disease. An aviator with a normal catheterization or only intimal roughening qualifies for Flying Classes II and III. Aviators with minimal CAD may receive a Categorical IIA or IIA waiver (Tanker, Transport, Bomber). **Minimal CAD** is defined as a sum of lesions of 120% or less, no single lesion with 50% or greater stenosis, and no left main coronary artery disease.
Aviators with waivers for minimal CAD are in an Aerospace Medicine Consultation Service Study Group and return annually for noninvasive testing. To assess any disease progression, they have repeat catheterizations at 3 years, or sooner if annual noninvasive test results become abnormal.

**Significant CAD (SCAD)** is anything beyond MCAD. Coronary stenoses 50% or greater are considered medically significant as they may cause myocardial ischemia with exertion. In addition, there is a higher cardiac event rate (MI, death) in individuals with SCAD. SCAD is considered disqualifying for all flying duties without waiver.

**Valvular Heart Disease**

With advancing technologies, primarily Doppler echocardiography, the sensitivity of detecting valvular stenosis and insufficiency has greatly increased over the past two decades. Many current guidelines for the evaluation of valvular lesions in aviators were derived from what are now considered relatively crude imaging techniques, as well as on the clinician’s exam. Now, for example, minimal insufficiency of the cardiac valves, identified using current methods of Doppler imaging, is so common that minimal insufficiency in the absence of any other valvular abnormality (i.e. associated stenosis or structural abnormalities) is not considered pathologic. Therefore, truly minimal (trace) insufficiency of any structurally normal valve is considered a normal variant and does not require further evaluation. The importance of structurally normal valves must be stressed, as a significant proportion of those with trace aortic insufficiency or trace mitral regurgitation also show a bicuspid valve or valvular prolapse, respectively. As well, again due to a greater sensitivity with current imaging systems, the conditions of mild mitral, tricuspid, and pulmonic insufficiency, in the presence of a structurally normal valve, normal chamber sizes, normal ventricular systolic function and hemodynamics, are considered normal variants requiring no further evaluation. (Mild aortic insufficiency, far less common and often associated with a bicuspid valve, is considered abnormal.)

The principal aeromedical concerns of valvular heart disease are as follows: the risk of bacterial endocarditis; associated dysrhythmias potentially exposing the aviator to incapacitation, or to a loss of situational awareness; the risk of embolic events; abnormal untoward hemodynamic effects in the high +Gz environment; myocardial ischemia, and a potentially high rate of pilot attrition due to progression of the valvular disorder and eventual left or right ventricular failure. Therefore, all aviators found to have moderate or severe regurgitation of any valve, mild to severe regurgitation of the aortic valve, or valvular stenosis of any degree require further evaluation, usually with referral to the Aeromedical Consult Service (ACS). This evaluation routinely involves a thorough history and physical examination by a cardiologist, confirmation of the valvular heart disease by echocardiography, an assessment of exercise tolerance as well as coronary artery disease screening by exercise treadmill testing (ETT), and 24-hour Holter monitoring for associated dysrhythmias. In addition, depending on the valvular disorder involved, its severity, and any associated disorders, further evaluation may be indicated with SPECT thallium-201 imaging, cardiac catheterization, or monitored centrifuge testing. Specific additional requirements will be discussed in the following paragraphs.
a. **Mitral Regurgitation (MR).** The majority of significant MR (greater than mild) that comes to the attention of the flight surgeon is secondary to mitral valve prolapse (MVP). Usually a soft pansystolic apical murmur radiating to the axilla is detected on a routine exam in an asymptomatic aviator. This may be associated with a midsystolic click with varies in relation to S₁, with standing and squatting. This condition is usually waiverable if there are no concomitant associated symptoms, other valvular heart disease, significant dysrhythmias, chamber dilation thought to be secondary to the MR, or depressed LV function. Mitral regurgitation due to other causes such as ruptured chordae tendineae, papillary muscle dysfunction or endocarditis is not generally waiverable. Reevaluations at the ACS are typically performed at three year intervals, though this may vary. In the case of MVP, those evauluees who wish to continue flying high performance aircraft are required to perform monitored centrifuge testing to assess their dysrhythmia potential.

b. **Mitral Stenosis (MS).** The presence of mitral stenosis in aviators is quite rare. Its etiology is almost exclusively secondary to rheumatic heart disease. As the diastolic low pitched rumble of MS is frequently missed on physical exam, this condition can go undiagnosed until the evauluee presents with symptoms. At this point the appropriate treatment is usually balloon valvuloplasty or surgical commissurotomy or valve replacement. Due to the associated high risk of recurrence or thromboembolic complications, mitral stenosis is considered disqualifying without waiver both before and after treatment.

c. **Aortic Insufficiency (AI).** The majority of significant AI (greater than trace) that comes to the attention of the flight surgeon is secondary to a congenitally bicuspid aortic valve. Usually a soft blowing diastolic murmur, heard best with the bell of the stethoscope at the mid left sternal border with the evauluee leaning forward, is detected on a routine exam in an asymptomatic aviator. This may be associated with a systolic ejection click, and can be accentuated with handgripping or a sudden squat. This condition is considered to be a contraindication to flying high performance aircraft due to the potentially adverse effects on the valve by elevations in aortic root pressure which occur due to afterload increases from sustained high-G stress. However, it is generally considered waiverable for non-high performance aircraft if there are no concomitant associated symptoms, aortic root disease, chamber dilation thought to be secondary to AI, significant dysrhythmias, or depressed LV function.

d. **Aortic Stenosis (AS).** The presence of aortic stenosis in the aviator is also quite rare. The etiology in this age population is almost exclusively a congenitally bicuspid AV. Though this congenital anomaly occurs in approximately 1% of the general population, the degree of calcific degeneration required to cause a gradient across this valve does not typically occur until the 5th or 6th decade of life. Aortic stenosis is usually easily appreciated on physical exam as a harsh crescendo-decrescendo systolic murmur heard best at the right upper sternal border, radiating to the carotids. A systolic ejection click may also be appreciated. Minimal AS, defined by a peak gradient less than 20 mm Hg in a ventricle with normal systolic function, may be considered for waiver. The evauluee must be asymptomatic, and have no associated dysrhythmias or left ventricular hypertrophy. More significant stenosis is not waiverable.

e. **Tricuspid Regurgitation (TR).** The majority of significant TR (greater than mild) is due to a pathologic process, usually pulmonary hypertension, right heart dilation, endocarditis or
tricuspid valve prolapse. The murmur is typically holosystolic, located at the lower left sternal border, and varies in intensity with respiration. If the underlying etiology is pulmonary hypertension or right heart dilation, it will usually not be waiverable. Pulmonary hypertension in particular can be aggravated by hypoxic-induced pulmonary vasoconstriction, potentially worsening the associated valvular regurgitation. TR due to TV prolapse or as an isolated finding is evaluated on a case by case basis and is potentially waiverable.

f. **Tricuspid Stenosis (TS).** Tricuspid stenosis is extremely rare in the general population as well as in aviators. The most common etiologies are rheumatic heart disease and carcinoid syndrome. It is disqualifying without waiver.

g. **Pulmonary Insufficiency (PI).** Significant (greater than mild) PI is also an uncommon finding in aviators. The majority of cases are secondary to pulmonary hypertension and therefore disqualified without waiver. Isolated cases not associated with this etiology may be considered on a case by case basis for waiver.

h. **Pulmonary Stenosis (PS).** In aviators this uncommon valvular lesion is generally secondary to a congenitally hypoplastic pulmonary valve. On exam, a systolic crescendo-decrescendo murmur is best heard at the left upper/mid sternum. Unlike AS, this is typically not a progressive lesion, and can be considered for waiver if there is no associated chamber dilation, right ventricular hypertrophy, dysrhythmias or conduction abnormalities.

i. **Mitral Valve Prolapse (MVP).** Mitral valve prolapse, with or without MR, is an aeromedical concern due to its relatively high prevalence in aviators (2-3%), and its association with tachydysrhythmias (SVT/VT), endocarditis, and thromboembolic events. The majority of MVP is detected on routine examination when a midsystolic click is heard. Typically the click moves closer to S1 when standing from a squatting position. Newer diagnostic capabilities and more rigid criteria for its diagnosis have led to a decreased estimate of prevalence from what earlier studies suggested. In part due to the earlier overdiagnosis of cases in the literature, this disorder had been linked to numerous conditions, with many of these associations yet to be definitively proven. However, a relatively firm basis exists for the associated complications listed above. Therefore the ACS established a Study Group to follow aviators with this condition to assess the natural history as it relates to the aviation environment and to be able to form a rational basis for waiver decisions. This Study Group is currently being reviewed.

For the present time, aviators with possible MVP are evaluated at the ACS. The diagnosis is confirmed either by agreement of two physicians on auscultation or by echocardiography demonstrating prolapse on the parasternal long axis or apical long axis views. Evaluation includes an echocardiogram, 24-hour Holter monitoring, and an ETT to detect exercise-induced dysrhythmias, decreased exercise tolerance or concomitant CAD. Further evaluation with SPECT thallium perfusion imaging may be necessary. Monitored centrifuge testing is required to fly high performance aircraft with this condition. Should there be no disqualifying associated dysrhythmias, reduced exercise tolerance, related chamber dilation, or decreased LV systolic function, waiver is usually granted.
Note should be made of the current ACS recommendations for SBE prophylaxis. We recommend that an evaluee with any valvular lesion associated with significant regurgitation as defined in the preceding paragraphs, any stenotic valvular lesion or thickened, deformed valve, any regurgitation associated with a murmur on exam, or MVP regardless of the presence or absence of MR, receive antibiotic prophylaxis for SBE.

**Hypertrophic Cardiomyopathy**

Although not waiverable, hypertrophic cardiomyopathy deserves comment because it is often found in a younger population, with an average age at presentation of 26 years old. It is usually detected in the aviation population by characteristic abnormalities on routine ECG rather than by symptoms. Even in the clinical literature 22% of patients are asymptomatic and more than 50% have no functional limitation, but hypertrophic cardiomyopathy is permanently grounding because of the risk of syncope and sudden death. Echocardiography makes a definitive diagnosis with a ratio of septal to posterior wall thickness of 1.3 or greater. The presence of LV outflow tract obstruction due to this hypertrophy is variable. Although the etiology is unknown, the heredity is autosomal dominant. If detected in an aviator, other family members should be screened.

A normal variant that may mimic concentric left ventricular hypertrophy (LVH) is the “athlete’s heart,” a compensatory cardiac response of muscle hypertrophy and mild chamber dilation to prolonged, strenuous exercise. Other evidence supporting this diagnosis besides an exercise history are signs of increased vagal tone such as sinus bradycardia, first degree atrioventricular (AV) block, Möbitz Type I second degree AV block and a junctional rhythm. The LVH observed with this entity may be waived if, after a period of minimal or no exercise, the LV returns to normal wall thickness and size as demonstrated on repeated echocardiograms. Once the diagnosis is confirmed, the aviator may resume the previous exercise program.

**Dysrhythmias**

The USAF Central ECG Library was established at the Aerospace Consultation Service (ACS) in 1957. Since then, it has been a repository of ECGs on aviators and has allowed serial comparisons. The Library has helped define the frequency, natural history and aeromedical significance of the various electrocardiographic abnormalities discussed next.

**Sinus Bradycardia.** Sinus bradycardia is a frequent finding in the young, physically conditioned USAF aviator with increased vagal tone. For this reason, sinus bradycardia is defined aeromedically as a sinus heart rate less than 50 beats per minute (bpm) rather than the usual 60 bpm. The aviator is disqualified if the bradycardia is due to sinus node dysfunction as shown by inadequate response to exercise or by abnormal electrophysiologic studies. A screening test the ECG library uses to exclude pathology is the “Hop-a-Gram,” where the subject jumps up and down until the heart rate reaches 100 beats/min, with a tracing obtained at that rate. Failure to reach a rate of 100 bpm requires a formal exercise tolerance test (ETT).

**Sinus Tachycardia.** Sinus tachycardia is defined as a sinus heart rate greater than 100 bpm. It is disqualifying if it is related to an underlying metabolic state or disease process, e.g.
hyperthyroidism. The underlying problem must be managed before aeromedical disposition can be decided.

**First Degree Atrioventricular (AV) Block.** First degree AV block is defined aeromedically as a PR interval greater than 0.22 sec instead of the usual 0.20 sec. This is an important distinction because as noted earlier sinus bradycardia is common in aviators, and the PR interval lengthens with decreased heart rate. The aeromedical evaluation of an aviator with first degree AV block involves assessment of the PR interval response to increased heart rate with exercise. Once again the “Hop-a-Gram” is used to exclude pathology; the subject exercises in place until the PR is demonstrated to shorten to <0.22 sec, documented on ECG. If the PR interval does not shorten to normal, an ETT is requested. If the PR interval still is abnormal, the first degree AV block is considered disqualifying and a ACS evaluation may be requested.

**Second Degree AV Block.** Möbitz I (Wenckebach) AV block can also be seen in the healthy, athletic aviator at rest or sleep due to increased vagal tone. It is considered a normal variant. Möbitz II AV block is disqualifying for flying duties because it is often indicative of significant conduction system disease and may lead to incapacitating hemodynamic events and third degree heart block.

**Right Bundle Branch Block (RBBB).** An ACS Study Group showed that, in an aviator with an otherwise normal cardiologic evaluation, RBBB is not an indicator of CAD or cardiomyopathy and is unlikely to progress to more serious conduction system disease. Therefore, waiver is usually recommended for flying training as well as Flying Class II duties if a local evaluation including internal medicine consultation, ETT, echo, and Holter monitor is normal. The aviator is DNIF during this evaluation. ACS evaluation is pursued prior to waiver recommendation if any of these studies is abnormal.

**Left Bundle Branch Block (LBBB).** LBBB is disqualifying for flying training. A trained aviator with LBBB as a serial change is evaluated at the ACS with cardiac noninvasive studies and catheterization because of an association with CAD, cardiomyopathy, and progressive conduction system disease. If all the studies indicate simple LBBB, a waiver may be recommended with ACS follow-up every three years.

**Ectopic Beats.** The aeromedical concern with ectopy is the possibility that the ectopy represents a sentinel finding for tachyarrhythmias. However, premature supraventricular contractions and premature ventricular contractions are common in healthy aviators and are frequently related to stimulants such as caffeine and alcohol. Premature supraventricular contractions (PACs, PVCs) are evaluated with Holter monitoring while the aviator remains on flying status. Rare (<0.1%), and occasional (0.1 - <1%) ectopy are considered normal variants. Frequent (1 - <10%) ectopy and paired ectopy are considered abnormal and mandate further testing, which consists of local ETT and echo. If these are normal then waiver for Flying Class II duties is usually recommended. Very frequent (>10%) ectopy, multiformed ectopy or frequent pairs (>10 in 24 hours) are abnormal and ACS evaluation is recommended.
**Supraventricular tachycardia (SVT)** is defined as three or more SV ectopics in a row at a heart rate greater than 100 bpm. It includes atrial tachycardia, junctional tachycardia, atrial fibrillation, and atrial flutter. Multifocal atrial tachycardia may or may not be considered abnormal requiring further evaluation; this is determined by individual case review. History of a single episode of SVT is disqualifying for flying training. Nonrecurrent SVT of 3-10 beats in duration requires local evaluation while the aviator is DNIF. The local evaluation will at least include internal medicine consultation, TFTs, three Holter monitors (one monthly for three months), and ETT. If an aviator has a single episode of nonsustained SVT of greater than 10 beats duration, or has recurrent nonsustained SVT (<10 minutes duration), or a single episode of sustained SVT, he may be considered for waiver after three additional local Holter monitors and subsequent ACS evaluation, with repeat ACS evaluations at three year intervals. The ACS evaluation consists of noninvasive cardiac studies tailored to the age of the aviator. If any of the CAD screening studies (coronary artery fluoroscopy (CAF), ETT, thallium scintigraphy) is abnormal, cardiac catheterization is required. Any symptomatic/hemodynamically significant SVT, or recurrent sustained SVT of sufficient frequency (<3 years between episodes), is considered permanently disqualifying for all classes of flying duties. Current SVT recommendations are based on the 1992 Surgeon General SVT Study Group review and analysis.

A generally benign form of SVT is the "holiday heart syndrome." This is usually atrial fibrillation related to fatigue, lack of sleep, hunger, and anxiety along with increased coffee, alcohol, and/or tobacco intake, and is usually self-limited. Future avoidance of the precipitating situation usually prevents subsequent recurrence of this arrhythmia.

**Ventricular tachycardia (VT)** is defined as three or more PVCs in a row at a heart rate of 100 beats/min or greater. It is disqualifying for entry into flight training. Asymptomatic idiopathic VT may be waived for flying in the trained aviator after ACS evaluation, consisting of cardiac noninvasive studies and occasionally catheterization studies. Flying Class IIA waiver is usually recommended for <5 episodes per evaluation if each is <12 beats duration. Waiver is not recommended if there is an underlying cardiac diagnosis with possible causal relationship (i.e. MVP, CAD, cardiomyopathy). A full Flying Class II waiver can only be recommended for a single episode of VT in the absence of arrhythmogenic substrate (>1% PVCs, any PVC pairing); the aviator must also undergo monitored centrifuge testing at the initial ACS evaluation. Aviators evaluated for VT at the ACS undergo yearly re-evaluation for two years, then re-evaluation at three year intervals. Current VT recommendations are based on the 1995 Surgeon General VT Study Group review and analysis.

**Short PR Interval Patterns.** Wolff-Parkinson-White (WPW) ECG pattern is the most common example. It is disqualifying for flight training but may be waived for trained aviators as a serial change. Waiver is usually recommended if an ACS evaluation reveals no WPW syndrome (i.e. tachyarrhythmias) or other evidence of organic heart disease. The evaluation may include monitored centrifuge testing if the aviator flies high performance aircraft. Cardiac catheterization is generally not included if noninvasive studies are normal. A short PR interval on ECG without a clear delta wave is evaluated locally. The aviator is interviewed for any prior history, either documented or subjective, suspicious for tachyarrhythmia. If there is no prior history of tachyarrhythmia the pattern is considered waiverable. If there is documentation or suspicion of
any tachyarrhythmia then the aviator is referred to the ACS for aeromedical recommendation and disposition. Waived aviators are re-evaluated at the ACS every three years.

**Hypertension**

Since hypertension rarely begins before the fourth of fifth decade, and thus would seldom be detected in the pilot applicant, the prevalence of this disease in the aviator population (10-20%) is significant, and only slightly lower than the U.S. adult population (17-28%). The difference is probably due to the increased prevalence of hypertension with increasing age and weight. The aeromedical concerns are the potential for sudden incapacitation due to stroke or myocardial ischemia and the overall increased mortality and morbidity associated with hypertension due to CAD, congestive heart failure and renal failure.

Detecting hypertension in the aviator, as in any other patient, requires blood pressure (BP) measurement in both arms with the proper sized cuff and the patient seated. According to AFI 48-123, atch 6, 15 Nov 94, an aviator is hypertensive if a 5-day BP check averages a systolic BP of greater than 140 mm Hg or a diastolic BP greater than 90 mm Hg. As long as the average systolic pressure does not exceed 160 mm Hg, and the average diastolic pressure does not exceed 100 mg Hg, the aviator may remain on flying status with a 6-month trial of nonpharmacologic management. If the average systolic BP is greater than 160 mm Hg, or diastolic BP is greater than 100 mm Hg, the aviator is disqualified from flying duties. This aviator, as well as one who fails nonpharmacologic management, should be started on medication and a waiver request submitted if adequate control is achieved with approved drugs.

**Treatment of Hypertension.** The six-month trial of nonpharmacologic management in certain aviators may include the following measures: weight reduction; sodium restriction; moderation of alcohol intake; regular aerobic exercise; and relaxation therapy and biofeedback. It is estimated that 25% of patients with mild hypertension can be managed with nonpharmacologic means. If the aviator fails nonpharmacologic treatment, or has a blood pressure elevation precluding such a trial, he should be grounded and begun on pharmacotherapy. The only antihypertensive agents which may be approved for MAJCOM waiver in the USAF are the thiazide diuretics, chlorothiazide or hydrochlorothiazide, although triamterene may be used in combination for its potassium-sparing effect. The U.S. Army has also approved prazosin and captopril for use by Army aviators. Most aviators can be controlled by diuretics and nonpharmacologic means, and the side effect profile is low; dyslipidemia resulting from thiazides appears to be clinically insignificant, and generally disappears within a year anyway. Some however are not well controlled by these means. If an Air Force aviator fails thiazides, he may be considered for ACE inhibitor therapy in consultation with the ACS. In that case, he should be continued (or placed back) on DNIF status, and begun on lisinopril. If he tolerates the drug without significant side effects, he should be referred to the ACS for evaluation and possible waiver.
METABOLIC PROBLEMS

Diabetes Mellitus and Glucose Intolerance

The currently recognized criteria for the diagnosis of diabetes mellitus is that established by the National Diabetes Data Group. The diagnosis of diabetes mellitus is made if the patient has: (a) classic symptoms and unequivocal hyperglycemia; (b) a fasting plasma glucose of 140 mg/dl or more, on more than one occasion; or (c) a fasting plasma glucose of less than 140 mg/dl but an abnormal response to the oral glucose tolerance test (200 mg/dl or greater at two hours, and at some other time between 0-2 hours). Patients with either (a) or (b) above do not require an oral glucose tolerance test to make the diagnosis of diabetes mellitus. If the initial diagnosis is made by an oral glucose tolerance test (OGTT) it should be a standard test with a 75 gram loading dose of glucose and blood sugar measurements every half hour for two hours. It is very important to properly administer the OGTT. Many other factors other than diabetes can cause an abnormal glucose tolerance such as inadequate physical activity or carbohydrate intake, and either inadequate or prolonged fasting prior to the OGTT. Also, illness, trauma and drugs such as thiazide diuretics may cause an abnormal response.

Aeromedically, the concerns of diabetes are hyper- and hypoglycemia, and neurological, renal, cardiovascular and visual complications. There also exists the possibility that the condition may be exacerbated by uncontrolled diet, chronic fatigue or other conditions encountered during deployment.

A Flying Class IIC waiver is possible if the diabetes is controlled by diet alone and there are no sequelae. Otherwise, patients with diabetes mellitus are disqualified. To apply for waiver, an internal medicine consultation is required. An MEB is not required for diet controlled diabetics. The initial waiver request should include at least three fasting blood sugar results <140 mg/dl, three measurements <175 mg/dl taken two hours after a meal, one measurement of glycosylated hemoglobin taken at least three months after control has been established and one measurement for islet cell antibody. Fasting blood sugar and glycosylated hemoglobin determinations should be obtained at least every six months in follow-up. For waiver renewal this data, as well as ophthalmologic and neurologic consultations, should be supplied with the package. Again, diet is the only treatment compatible with flying; the use of insulin or oral hypoglycemic agents is disqualifying without waiver. (AFPAM 48-132)

Hyperlipidemia

Hyperlipidemia has aeromedical significance because of the increased risk of developing coronary artery disease (CAD) and because risk modification measures can reduce that risk. Elevated total cholesterol, elevated LDL cholesterol and reduced HDL cholesterol have all been shown to be independent risk factors for the development of CAD. The ratio of total cholesterol to HDL cholesterol has also been shown to be a sensitive predictor of CAD risk and is convenient because it incorporates two of the above three predictors. In a series of aviators undergoing
angiography at the Aeromedical Consultation Service for an abnormal treadmill test, 64% of those with a ratio greater than 6.0 had CAD while only 2% of those with a ratio less than 6.0 had CAD.

HDL cholesterol is normally 20-25% of total plasma cholesterol level and is independent of age in adult life. Increased intake of dietary cholesterol and saturated fats decreases HDL cholesterol, as does smoking. Aerobic exercise and moderate alcohol intake increase HDL cholesterol. Therefore, risk modification measures for an aviator with elevated total serum cholesterol or total cholesterol/HDL cholesterol ratio include smoking cessation, lowered intake of cholesterol and saturated fats, weight loss to achieve ideal body weight and a graduated aerobic exercise program tailored to the individual. Prescribing moderate alcohol intake to increase HDL cholesterol levels has not been shown to have a CAD risk reduction benefit. Drug therapy may be considered if diet and other nonpharmacologic methods are not effective to achieve the target goal. Although criticized for being too aggressive, the National Cholesterol Education Program (NCEP) recommendations (JAMA, 16 Jun 93, Vol 269, p 3015-3023) contain very organized and systematic algorithms to direct nonpharmacologic and pharmacologic therapy. Additionally, the NCEP recommendations incorporate total cholesterol, HDL cholesterol and LDL cholesterol in their scheme. Currently, cholestyramine and colestipol are approved for use in aviators with a Flying Class II or unrestricted waiver. Lovastatin and gemfibrozil are approved for categorical or nonhigh performance flying waiver (IIA/IIIA). Niacin is not approved for use in rated aviators. Choice of medication should be guided by the aviator's overall lipid profile and actions of the individual medication. For instance, cholestyramine tends to elevate triglyceride levels and would be an inappropriate choice in an aviator with already elevated triglyceride levels.

Hypercholesterolemia alone may be disqualifying for entry into flying training. AFI 48-123, 15 Nov 94, has much simpler disqualifying criteria for elevated lipids than the previous AFR 160-43. Section A6 states that the following criteria are disqualifying for Flying Class I/IA: total cholesterol level greater than 300 mg % confirmed by repeat determination or HDL cholesterol level less than or equal to 15% of the total cholesterol level in the presence of a total cholesterol greater than 230 mg %, again confirmed by repeat determination. Abnormal lipid profile alone is not disqualifying for rated aviators, however. According to Section A6, the following criteria are cause to send an ECG and aeromedical summary to MAJCOM/SG and to the Aeromedical Consultation Service for further recommendations: a) total cholesterol greater than 300 mg %, confirmed by repeat determination, or b) total cholesterol between 230-300 mg % and cholesterol/HDL ratio greater than 6 or LDL cholesterol greater than 160 mg % confirmed by repeat determination or c) abnormal lipid profile with concerning risk factors.

PULMONARY PROBLEMS

Symptomatic pulmonary disease is rare in aviators. Occasionally, pulmonary problems in aviators are detected by abnormal pulmonary function tests (PFT). Aeromedically, abnormal PFTs alone are not disqualifying but the aviator must be thoroughly evaluated.
Chronic obstructive pulmonary disease (COPD)

This includes both chronic bronchitis and emphysema. COPD is disqualifying for initial flight training, but may be waived for Flying Class II or III after careful evaluation if the aviator is asymptomatic or has only minimal symptoms, has no evidence of reactivity, and requires no medication. Smoking cessation is essential. Bullous emphysema is disqualifying because of the risk of rupture and pneumothorax at altitude.

Reactive Airway Disease

Asthma or a prior history of asthma is disqualifying for flying training. It is also disqualifying as a new condition in rated aviators because it can be adversely affected by many stressors in the aviation environment such as cold dry air, smoke and fumes, pressure breathing, exertion, and possibly high +Gz. No medications for treatment of asthma are currently authorized for use by USAF aviators.

Sarcoidosis

This systemic granulomatous disease of unknown etiology usually is detected in a healthy, asymptomatic aviator with the finding of bilateral hilar lymphadenopathy on chest x-ray performed for other reasons. Occasionally, the aviator presents with cough, wheezing, fever, malaise, mucoid sputum production, and/or weight loss. About 80% of patients presenting in this way have complete resolution of the findings within 2-5 years, usually with the chest x-ray clearing within 6-24 months. About 5-10% of patients go on to develop severe chronic disease with pulmonary insufficiency and cor pulmonale. The main aeromedical concern is possible cardiac granulomata which have been associated with bundle branch blocks, AV dissociation, ectopy, paroxysmal tachyarrhythmias, coronary artery compression, and sudden death. An aviator presenting with an abnormal chest x-ray or symptoms as above requires a thorough evaluation to rule out other disorders, and to rule out significant visceral involvement. The aviator is grounded and referred to an internist, or preferably a pulmonologist if available. The evaluation should include LFTs, PFTs and Holter monitor, as well as an appropriate biopsy to establish the diagnosis. Acceptable biopsy sites include conjunctiva, tail of the parotid gland, and the lung, in increasing order of invasiveness but also increasing order of yield. If the local evaluation shows no abnormality (except compatible histopathology on the biopsy) a FC II waiver is recommended, with reevaluation every two years unless symptoms arise sooner. If there is evidence of involvement of the myocardium or nervous system, or evidence of significant disease of any other viscera (e.g. restrictive lung disease, granulomatous hepatitis) the aviator is disqualified.
GASTROINTESTINAL AND GENITOURINARY PROBLEMS

Gastrointestinal Hemorrhage

Gastrointestinal hemorrhage is disqualifying, but waiverable if a specific treatable and nonpersistent cause is clearly identified. Waiver may be granted for single or recurrent uncomplicated gastric or duodenal ulcers that (a) are subsequently asymptomatic for six months with negative monthly hemoccults, (b) heal completely in the expected treatment period, and (c) require no maintenance medication, specialized diets or meal patterns. Diagnosis and response to treatment must be confirmed by radiographic techniques and/or endoscopic studies with additional procedures (biopsy, culture or cytology) as indicated. Ulcers which require surgical treatment may be waived if the procedure is definitive, and the aviator requires no adjunctive medications or occupational restrictions as defined by aeromedical standards. Preventive lifestyle changes, such as avoidance of NSAIDs, alcohol, tobacco, and coffee (both regular and decaffeinated) are strongly encouraged.

Renal Stones

The aeromedical importance of stones is twofold. The abrupt onset of incapacitating pain could be very hazardous in flight, especially in a single-seat aircraft. Also, prolonged flights and hot environments increase the problem of dehydration associated with stones.

Aviators may present either symptomatically or with stones found incidentally on x-ray. The aeromedical evaluation includes an excretory urogram to localize the stone and rule out any congenital or acquired anomaly, renal function studies, and a metabolic workup with 24-hour urine calcium, uric acid, oxalate and cysteine levels. Single or recurrent attacks of renal colic may be waived if the stone or stones have passed, and if the above evaluation is normal. Aviators with retained stones must be evaluated by a urologist. The aeromedical decision depends on the location of the stone, its potential for movement, and on whether the aviator is a candidate for any procedure to remove the stone such as endoscopic manipulation, lithotripsy, or surgery. An aviator is usually qualified for unconditional flying (FC II or III) if the retained stone is parenchymal or is in a calyceal diverticulum and is larger than the diverticulum neck, and if the metabolic and renal evaluations are normal. A categorical (IIA or IIIA) waiver is given if the stone is in the papillary duct or any more distal part of the collecting system, and the renal and metabolic evaluations are normal.
AEROMEDICAL MANAGEMENT OF FLYING PERSONNEL WITH NEOPLASMS

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Therapeutic advances in medical and surgical oncology have cured or returned to their pre-illness levels of function a select group of military aviators. This has provided the opportunity to utilize the investment/experience of these aviators by returning them to flying status when appropriate. The process of returning an aviator with a neoplasm to flying status usually involves multiple specialists, sometimes in multiple hospitals and orchestrated by several flight medicine services.

Actions to take at the time of diagnosis

Take the individual off flying status.
Discuss with the primary physician managing the aviator’s care, what are the prospects for cure and/or functional recovery. (Wilford Hall pathology staff, specifically the Chairman, Col. Drehner or Maj. Stokes at DSN 554-7741 are always available to answer any questions.)

Prognosis is favorable or uncertain as to return to flying duties. Discuss with the aviator’s oncologist the need for baseline studies. The list of toxicities associated with various therapies is long. Depending on the agents being utilized in the aviator’s therapy, baseline studies should be done to document pre-treatment status. Some treatment regimens, in addition to physical toxicities, have significant risk of residual neuro-psychological problems. For example there is a report of a high rate of neuropsychiatric complications, over 50%, in patients undergoing bone marrow transplantation. This risk became an issue in evaluating a pilot of a high performance aircraft for return to flying status after allogeneic bone marrow transplant for chronic myelogenous leukemia (David DG, Patchell RA. Neurologic complications of bone marrow transplant. Neurologic Clinics 1988; 6:377-387). The absence of baseline studies complicated the waiver process for that individual.

Maintain contact with the aviator in the treatment phase. It is important for the aviator and physician. The illness removes the aviator - patient from his profession and his sense of self worth. Continued interaction with the unit flight surgeon and other squadron members is concrete evidence of the promise of a good prognosis. For the flight surgeon it is perceived as a key measure of competence by the squadron. In the maelstrom of activities filling your day, it is difficult to make time for these patients. If their care is being provided outside the immediate area of your facility maintain contact by phone.

Participate in the tumor board where the aviator’s treatment plan is discussed. Not only do you help the board by providing the aeromedical perspective but you become identified as the person to whom information about the patient’s care should go. This smoothes the later waiver process.
When the aviator is disqualified from flying status continue to be sensitive to his family’s medical needs. Aviators with some malignancies may be disqualified for several years. While their care should revert to the other clinical services of your MTF, consider how you would want your family to be treated. Shifting of patient care responsibility can be perceived negatively by the squadron. Your credibility as a physician can be lost by mistakes in this area.

Insure the patient’s outpatient record contains relevant summaries of hospitalizations, surgeries and treatments. It’s not your responsibility. However, if you correct deficiencies in the database at this time you’ll recoup your investment when you put the waiver package together.

**Prognosis is unfavorable for return to flying status and/or recovery.** This is the reason you are a physician. Sensitivity to the needs of the aviator and his family should be a paramount concern to you. There is no school solution to this problem. Find out what you can do to help and do it.

**Obtaining a waiver - returning the cured**

AFPAM 48-132 is necessary reading before preparing a waiver request. For most common and many uncommon neoplasms it details the USAF experience. It tells you how long aviators characteristically are disqualified from flying duties for the various malignancies covered. Squadron Leader Michael Gibson, the RAF Exchange officer with the USAF Surgeon General’s office, recently completed this insightful document. The Surgeon General’s Office has the waiver authority for malignancies.

**Components of a waiver package**

1. Current aeromedical summary and physical exam. In the aeromedical summary include the type(s) of aircraft the aviator flew, number of hours, summary of treatment, any residua and his functional status. A current physical is helpful. Using a physical from before diagnosis of the malignancy is suspect particularly in malignancies requiring treatments with systemic effects. In the aeromedical summary address the functional status of the aviator in light of the demands of his likely subsequent assignments. Can the aviator perform adequately in a deployment or wartime environment?

2. If the therapy entailed treatments with documented increased risks of side effects of aeromedical import studies should be done to document adequate function for aviation duties. For example, adriamycin, a chemotherapeutic agent has been associated with cardiac damage. A thallium scan may be indicated to rule out this effect.

3. Secure a tumor board evaluation. A flight surgeon should be a member of the tumor board. Send an aeromedical summary with the tumor board request. The information in the aeromedical summary about the aviators functional status and likely assignments is key information for the members of the tumor board. Before the case is sent to the tumor board check whether the diagnostic pathology specimen(s) was reviewed by the Armed Forces Institute of Pathology for their concurrence in the diagnosis. This is mandated by Air Force Regulations, except in the case of Basal Cell and non-invasive squamous cell cancers. Carefully review the
tumor board recommendations. Sometimes hospital based physicians are unaware that a requirement for follow-up every three months would remove the aviator from mobility position.

4. Discuss the case with both your command surgeon and the waiver section at the Surgeon General’s Office. Your objective is to get their input about any tests or consultations they may require for evaluation of the package.

After the waiver
It is a good idea for the aviator to retain copies of certain key components of his medical record. These include: a record of any surgeries done as part of his/her treatment; a copy of the diagnostic surgical pathology report and if possible a copy of the glass slides; copies of key x-rays and other diagnostic studies, and a summary of therapies.

Finally, be vigilant in screening for complications of therapy and relapse.
REFERENCES

1. AFR 160-43. Medical Examination and Medical Standards.


