Areas of Recent Interest in the U.S. Air Force
Aeromedical Consultation Service

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Disclosure Statement

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The views expressed are those of the author and do not necessarily reflect the views of the United States Air Force or the United States Government.

I have no relevant financial relationships to industry.
Overview

General Concepts of (Flying) Waivers in USAF
- Philosophy
- Process

Role of the Aeromedical Consultation Service (ACS)
- Branches

Selected Topics of Interest for ACS
- Unilateral hearing loss – operational evaluation
- Aerospace cardiology – digital EKG library and screening for coronary disease
- Aviation refractive surgery program
- Obstructive sleep apnea
Philosophy

Waivers provide flexibility to keep aviators flying if it can be determined it is safe to do so

Waivers are designed to benefit the AF (by preserving investment in an asset)

Waivers should be based on data that indicate the aviator may safely fly with his/her diagnosis subset even though the broader diagnosis is disqualifying

Waivers thus “waive” the strict letter of the AF instruction
Philosophy

General Waiver Information

To be considered waiverable, any disqualifying condition should meet the following criteria:

- Not pose a risk of sudden incapacitation
- Pose minimal potential for subtle performance decrement, particularly with regard to the higher senses
- Be resolved or be stable and be expected to remain so under the stresses of the aviation environment
- If the possibility of progression or recurrence exists, the first symptoms or signs must be easily detectable and not pose a risk to the individual or the safety of others
- Cannot require exotic tests, regular invasive procedures, or frequent absences to monitor for stability or progression
- Must be compatible with the performance of sustained flying operations in austere environments
Process

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- All waiver authority ultimately rests with the AF Surgeon General (AF/SG)
- For some diagnoses, this authority is delegated to a lower level
- Certain diagnoses can be waived at a local level, some at the MAJCOM level, some must be reviewed at AF/SG staff level
- Difficult cases can be referred to the ACS
  - The ACS functions as a subject matter expert, but waiver authority is retained by the referrer
Role of the ACS

The ACS exists as part of the USAF School of Aerospace Medicine at Wright-Patterson Air Force Base, Ohio.

Reviews cases based on a submitted aeromedical summary and supporting documents.

- Decisions can in many cases be rendered on this material alone.
- Some cases require in-person evaluation.
Unilateral H3 or worse hearing loss presents potential for operational safety degradation:

- Any circumstance requiring stereoacusis
- Particularly concerning when critical inter-crewmember communication is involved

Need to confirm process is static, nonprogressive

- Significant difference left/right hearing raises question of process other than noise-induced hearing loss
- Can also be medically induced (e.g., treatment for vestibular schwannoma)
Unilateral Hearing Loss – 2

To date, no validated in-office test reliably correlates with whether aviator can safely perform operational duties.

Waiver recommendation is based on in-flight evaluation.

Not all “medical” evaluations in aviators can be done in the office.
Cardiology and the Aviator 1

What we know we know

- Which are important considerations in aviators with coronary artery disease (CAD)?
  - Myocardial ischemia with high-G maneuvers
  - Hemodynamics of hypertensive therapy
  - Risk of sudden cardiac death, myocardial infarction, and ischemic dysrhythmias

- Of course, all are!
How do we know, what do we really know?

- Not enough to know broadly
- Need to know when the aviator can return to duty and what, if any, limitations there are
- Need to detect disease before an event but not cause excessive downtime with false positives

Cannot use generally available cardiac data in the literature – based on different population

- Would lead both to excessive testing and grounding of aviators
ACS Cardiology – Introduction

• New Technology
  • Picture Archive Communication System (PACS)
  • The world’s largest digital cardiac database
  • Worldwide real-time consultation

• New Evidence
  • Screening for CVD
  • Calcium scoring policy
Established in April 1957
Serves as a repository of all cardiovascular studies on rated aviators in the USAF, USAFR, and ANG
- AFI mandate, all rated aviators (pilots, navigators, flight docs, air battle managers, load masters) for both surveillance and other cardiac studies accomplished for any reason

Aeromedical Consult Service Mission: Conduct and Manage
- Aeromedical Evaluations/Consultations
- Aeromedical Education and Teaching
- Aeromedical Research
- Aeromedical Operational Support
- Medical Flight Screening
Since the 1950s the library annually receives, interprets, and databases up to

- 25,000 ECGs
- 250 echocardiograms
- 250 treadmills
- 175 Holter monitors
- Numerous CT/MRI and catheterizations
- 100% digitized as of 31 Dec 2011!

Aeromedical disposition and waiver policy

- 60 yr of aviator data for a specific population
- Outcomes data and policy changes almost monthly
- Work groups for normal, variant normal, and abnormal
- As of 26 Jan 2012, there are 1,212,265 studies on 283,157 aviators
World’s Largest Digital Cardiac Library

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ACS Archive (1.2 million studies)

ACS or FS clinic studies
*Direct or Download*

PACS – HL7, DICOM and PDF digital archive

FS clinic or civilian studies
*Direct or Download*

ECG, Treadmill, Holter Devices

FTx Interface* with expanded storage**

12 lead ECGs

Non-standard ECGs and Image Data

PACS Processing

ECG Processing
The All New ACS Central ECG Library

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- Elimination of lag-time, backlog, and need for excessive manpower for paper/by-hand tracking, logging, storage interpretation, response, and archive in multiple databases
- Improved physician productivity and ability to monitor pilot health
- Automated workflow/image management, decreased medical errors
- The capability to collect, display, store, retrieve, transmit, and archive diagnostic quality cardiac images/studies for analysis and interpretation
- The ability to capture all ACS cardiac studies in original raw data format
- Ability to easily retrieve new and relevant prior studies for pilots
- Sophisticated analysis and reporting capabilities
- Decrease in unnecessary and costly medical evacuations
- Decreased unnecessary tests/treatment, potential harm
- Decreased anxiety and angst by pilot/flight surgeon
- Increased compliance with study submission
- Better data for research, waivers, USAF policy
- Real-time expert response to critical cardiac questions

**Expedite aeromedical cardiovascular decisions. Decrease DNIF time. Mission Completion!**
### Screening Echocardiography

**All pilot candidates screened with echocardiograms 1994 – 2008**

- **90% of DQ diagnoses = MVP, BAV, mild AI (trileaflet valve), BAV w/mild AI**

<table>
<thead>
<tr>
<th>Period</th>
<th>Waiverable Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994-1998</td>
<td>0%</td>
</tr>
<tr>
<td>1998-2004</td>
<td>52.3%</td>
</tr>
<tr>
<td>2004-2006</td>
<td>98.9%</td>
</tr>
</tbody>
</table>
In fact, if we apply current waiver policies to all echos performed since MFS inception in 1994, screening performance is dismal:

- **20,208** total echos from inception, 1994, until September 1, 2006
- **294** Disqualifying (1.45%)
- Of the **294**, exactly **9** would not be eligible for a waiver under current policy
Diagnoses of the 9 DQ/No-waiver under current policy:

- BAV Moderate AI
- BAV Moderate AI/Moderate AS
- Repaired Tetrology of Fallot
- Moderate AI
- Coronary Artery Fistula
- Mild Aortic Stenosis
- Pericardial Effusion/CT Disorder
- Hypertrophic Cardiomyopathy
- Moderate MR/Moderate MS
- Idiopathic Dilated Cardiomyopathy
Handling of DQ/Waiverable

❖ **Continue to follow in ACS management groups for longitudinal data**

❖ **Recent BAV/AI analysis:**
  
  ❖ **AsMA 2006 short-term f/u on BAV**
  
  ❖ **Mean age 43, N = 63, f/u = 4 yr**
  
  ❖ **17% progressed to restrictions/DQ (all but one > 40 yr old)**
  
  ❖ **Thus serial follow-up warranted when abnormality identified but does not justify systematic screening per se**
MFS Echo Screening: Summary

- Low numbers of DQ/no-waiver due to evolution of policy no longer justify wholesale screening of applicants
- Most abnormalities will eventually be identified
- Once identified, serial follow-up is indicated (as the ACS is currently doing)
- On the whole, change to H&P directed screening expected to reduce costs without compromising mission effectiveness/flying safety
Challenge of Screening for CAD in Aviators

Test with 80% Sensitivity, 90% Specificity Population
20,000 subjects, **50% prevalence** CAD

<table>
<thead>
<tr>
<th></th>
<th>Significant CAD</th>
<th>No Significant CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal Test</td>
<td>8,000 (TP)</td>
<td>1,000 (FP)</td>
</tr>
<tr>
<td>Normal Test</td>
<td>2,000 (FN)</td>
<td>9,000 (TN)</td>
</tr>
</tbody>
</table>

\[
PPV = \frac{TP}{(TP+FP)} = 89\% \\
NPV = \frac{TN}{(TN+FN)} = 82\%
\]
Challenge of Screening for CAD in Aviators

Test with 80% Sensitivity, 90% Specificity Population, 20,000 subjects, 5% prevalence CAD

<table>
<thead>
<tr>
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<th>Significant CAD</th>
<th>No Significant CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal Test</td>
<td>800 (TP)</td>
<td>1,900 (FP)</td>
</tr>
<tr>
<td>Normal Test</td>
<td>200 (FN)</td>
<td>17,100 (TN)</td>
</tr>
</tbody>
</table>

**PPV** = \( \frac{TP}{TP+FP} = 30\% \)

**NPV** = \( \frac{TN}{TN+FN} = 98\% \)
903 aviators with treadmill, thallium, and cardiac fluoroscopy for coronary artery calcification

Mean age 43.7 yr, mean f/u 11.8 yr

Sensitivity, specificity, positive predictive value, and negative predictive value for moderate or greater CAD (>50%) and severe CAD (>70%)

Average annual event rates at 2/5 yr
Noninvasive Tests

For detection of moderate or greater CAD (≥50% stenosis)

<table>
<thead>
<tr>
<th></th>
<th>Treadmill</th>
<th>Thallium</th>
<th>Fluoroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sens</td>
<td>54%</td>
<td>55%</td>
<td>68%</td>
</tr>
<tr>
<td>Spec</td>
<td>49%</td>
<td>62%</td>
<td>71%</td>
</tr>
<tr>
<td>PPV</td>
<td>16%</td>
<td>21%</td>
<td>29%</td>
</tr>
<tr>
<td>NPV</td>
<td>86%</td>
<td>89%</td>
<td>93%</td>
</tr>
</tbody>
</table>
ACS uses exercise stress, nuclear imaging, and coronary artery calcium detection in screening for coronary artery disease in USAF aviators.

None of the tests perform well; however, abnormal results on any one of the three do correlate with increased annual event rates.

In this population, coronary artery calcium detection is the best test for screening for CAD.
Comparison of Event Rates

Angiography Summed Score

- **Min CAD (aggregate <50%)**: 0.5% to 1.0%/yr; Annual Re-eval
- **Mod CAD (aggregate 50-120, no lesion > 70)**: 1.0% to 2.0%/yr; Annual Re-eval; cath q 5 yr (NEW)
- **Sev CAD (aggregate > 120 or lesion > 70)**: 3.0% +/-/yr; DQ – no waiver

CAC Score (literature)

- **CAC 0-9**: 0.00%/yr
- **CAC 10-100**: 0.5% to 1.0%/yr
- **CAC 101-399**: 1.0% to 2.0%/yr
- **CAC >400**: 3.00%/yr and up

Outcomes for CAD are driven by overall burden of disease, regardless of how measured
CAC Tests Disposition

**CAC tests with a score of 0-9** are considered normal and do not require waiver submission or ACS evaluation.

**CAC tests with a score of 10 or greater** are considered abnormal and require waiver submission and ACS evaluation IAW AFI 48.123 V3 A4.18.1.5.

(Evaluation to include decision on whether to do coronary angiography will be left to another presentation)
The USAF began to waiver aviators after PRK in 2001 and LASIK in 2007

In the beginning, all pilots and navigators had to come to the ACS for very thorough evaluations prior to waiver consideration

LASIK was delayed for several years due to concerns with the stability of the flap

Newer flaps are much less likely to dislodge
Myopic CRS

• Central cornea flattened

Hyperopic CRS

• Peripheral cornea flattened

Astigmatic CRS

• Asymmetric treatment
Types of CRS

- Advanced **Surface** Ablation (ASA)
  - PRK – Photorefractive Keratectomy
  - Epi-LASIK
  - LASEK - Laser Assisted Sub-Epithelial Keratomileusis
Types of CRS

- Intra-**stromal** Ablation (ISA)
  - LASIK - Laser Assisted In-Situ Keratomileusis
Types of CRS

• Intra-**Stromal** Ablation (ISA)
  ➢ Femtosecond LASIK (Intralase)
Other Types of CRS

- Intra-Stromal Corneal Rings (Intacs)
- Radial Keratotomy (RK)
- Phakic Intraocular Lens (IOL)
What Type of Refractive Surgery Is Approved?

Only ISA and ASA are approved for aircrew.

Intacs, RK, and Phakic IOLs are **NOT** approved.
Advanced Surface Ablation (PRK)

**Pros**
- Structural integrity of eye maintained
- Conservative surgical option
- Possibly better vision than ISA

**Cons**
- Slow visual recovery (months)
- Discomfort 72-96 hours after procedure
- Long steroid taper (IOP control)
Intra-Stromal Ablation (LASIK)

**Pros**
- Rapid visual recovery
- Nearly pain free

**Cons**
- Surgical complications associated with flap creation
- Lifetime risk of flap dislocation
- +/- Altitude effects
Uncorrected 5% Acuity after CRS

- ASA
  - 3-6 months for stability
- ISA
  - Rapid recovery
Outcomes

95%+ of aircrew meet distant acuity standards **without** correction
  - *Presbyopia may dictate need for near correction*

~5%-10% lose one or more lines of acuity **without** correction after CRS versus best correction before surgery

1%-2% lose one or more lines of **best corrected** visual acuity

Permanent DQ rare – 2 cases in ~3000 treatments since 2000
  - **One due to optic nerve damage from IOP spike**
  - **One due to poor outcome (treated above myopia limits of program)**
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USAF Aviation Refractive Surgery Program

Post-Surgical Waiver

Member is eligible for MAJCOM waiver when:

• Meets required vision and refractive criteria*
  ➢ 20/20 on OVT
  ➢ 20/50 on Precision Vision 5% chart
  ➢ OVT depth perception
  ➢ Cycloplegic refraction

• Demonstrates refractive stability-
  ➢ Two manifest refractions at least 2 weeks apart with no more than 0.50 D difference.

• Normal eye exam
  ➢ Slit lamp, dilated fundus exam, IOP

* If lens correction required to be 20/20 or pass DP, then lenses required for flying
Obstructive Sleep Apnea

- **Common disorder amongst Americans**
  - 4% of males and 2% of females affected
- **More frequent in obese individuals and those with a large neck circumference**
- **Often becomes bothersome to sleep partner due to loud and frequent snoring**
- **Predominant symptom is daytime sleepiness**
- **Great concern in aviators with neuropsychological deficits: memory, attention, and executive tasks**
  - Deficits can be long term
Diagnosis

- Symptoms are the driver for an evaluation
- Diagnosis requires a sleep study or polysomnography
  - Observation of a nocturnal sleep episode with EEG, submental electromyography, electro-oculography, measurements of airflow and thoracic/abdominal excursion, and oximetry
  - Our rated aviators need to be tested at the ACS
- Another test is the multiple sleep latency test, which measures the time required to fall asleep
Diagnosis

The Maintenance of Wakefulness Test (MWT) is a measure of the volitional ability to stay awake

- Seated in a quiet dimly lit room and instructed to stay awake – test lasts 40 minutes
- If they fall asleep in less than 8 minutes, the MWT is abnormal
Treatment Options

- **Weight loss** is recommended in a majority of cases
- **Positional therapy**
- **Oral appliances**
- **Continuous positive airway pressure (CPAP)**
  - Can use with varying types of masks or nasal prongs
  - Incompatible with unrestricted worldwide qualification
  - Requires a continuous power supply and dust-free environment
- **Surgery** – several techniques and all have only modest results
Aeromedical Concerns

- Excessive daytime sleepiness and decreased alertness
- Decreased neuropsychological abilities
- Difficulty adapting to circadian changes
- Deployment restrictions
USAF Waiver Experience

Over 650 aircrew submissions for a waiver
About 75% receive a waiver