



THE LIFETIME SURVEILLANCE OF ASTRONAUT HEALTH
Newsletter

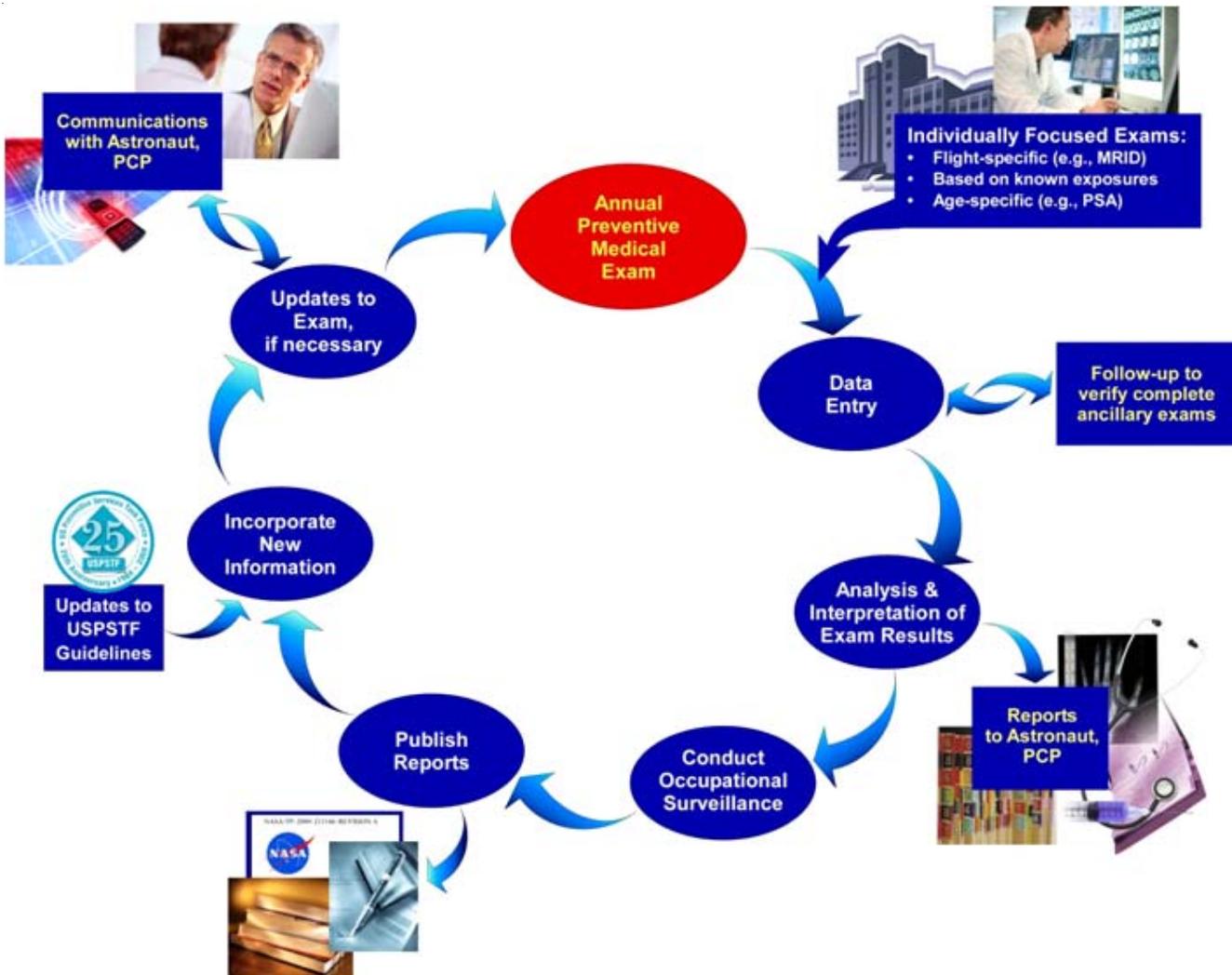
Spring 2011

UPDATE ON THE NEW LIFETIME SURVEILLANCE OF ASTRONAUT HEALTH (LSAH) PROGRAM: COMPREHENSIVE MEDICAL EXAMS

BY: LESLEY LEE, M.S.

The June 2010 LSAH newsletter introduced the change from the Longitudinal Study of Astronaut Health research study to the new Lifetime Surveillance of Astronaut Health program (“An Overview of the New Occupational Surveillance Program for the Astronaut Corps”). Instead of performing research-focused retrospective analyses of

astronaut medical data compared to a JSC civil servant control population, the new program is focused on prevention of disease and prospective identification and mitigation of health risks in each astronaut due to individual exposure history and the unique occupational exposures experienced by the astronaut corps. The new LSAH program has 5 primary goals: (1) Provide a comprehensive medical exam for each LSAH participant;



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(2) Conduct occupational surveillance; (3) Improve communication, data accessibility, integrity and storage; (4) Support operational and healthcare analyses; and (5) Support NASA research objectives. This article will focus primarily on the first goal, the comprehensive medical exam. Future newsletters will outline in detail the plans and processes for addressing the remaining program goals.

During the past year, recommendations from the Institute of Medicine and other experts in the field of occupational surveillance have been incorporated into planning the new LSAH. The program is designed to fit the medical follow-up care to the individual since not all astronauts have been equally exposed to hazards before, during, or following their NASA career. The new LSAH is also designed to enhance communications with astronauts and their primary care physicians (PCP). The purpose is to facilitate continuity of medical care and follow-up between JSC and personal clinicians. The diagram (see page 1) illustrates the main elements of the annual exam process.

Primary medical evaluation of the individual will include a comprehensive medical history, complete physical examination, medical laboratory tests, and ancillary diagnostic medical tests. This will be supplemented with individually focused exams based upon each person's status and experiences. For example, Medical Requirement tests may be included for those currently assigned to a mission, and age-based tests may be added at certain milestone ages (e.g. colonoscopy at age 50). Other tests may be added for those who have had previous occupational exposures to hazards such as cadmium or hydrazine. Additional tests may also be recommended if the occupational surveillance element of LSAH provides new evidence indicating that further screening is warranted. This comprehensive set of exams will be tailored to each individual and coordinated to be as convenient as possible for participants. Testing will be conducted at JSC and at local facilities that offer a wide spectrum of medical screening/testing capabilities. This will minimize astronaut travel and wait times. In the event an astronaut cannot travel to Houston,

arrangements will be made with the primary care provider for performance of the tests in or near the astronaut's home town.

Following the exams, LSAH and the Flight Medicine Clinic physician will provide a thorough summary and analysis of results to astronaut and their PCPs. Recommendations for follow-up care in the intervening year may also be discussed. The astronaut's exam results will be documented in the FMC electronic medical record system. Surveillance is the ongoing systematic collection, analysis, and interpretation of health data for purposes of improving health and safety. Data gathered in this process are used to improve astronaut safety and health and to monitor health trends over time. LSAH surveillance will involve the timely dissemination of these data to those who need to know, including publication of non-attributable data, and proactive application of these data to the astronaut clinical care setting. Astronauts and their PCPs will be among the first to receive notice of any publications resulting from the occupational surveillance program.

LSAH will also monitor the United States Preventive Services Task Force (USPSTF) for updates to national guidelines regarding preventive medicine exams. New guidelines and recommendations will be incorporated into the preventive medicine exams if determined to be appropriate to the astronaut population. The new LSAH provides the opportunity for astronauts and their PCPs to be more actively involved in the clinical care process. The more comprehensive annual exams, occupational surveillance, and active participation of astronauts benefits individual astronauts. It also provides NASA with a more complete understanding of the relationships among spaceflight-associated health hazards and medical outcomes. The information to be gained is essential for planning, implementation, and evaluation of aerospace medicine practices for the ultimate safety of current and future astronauts.

TRADITIONAL CARDIOVASCULAR RISK FACTORS AS PREDICTORS OF CARDIOVASCULAR EVENTS IN THE U.S. ASTRONAUT CORPS

BY: MELISSA HALM, MPH and E. AMIRIAN, PhD

The Framingham Risk Score (FRS) assesses the absolute 10-year risk for myocardial infarction (MI) and coronary heart disease (CHD)-related death, using a predictive model developed from data collected during the Framingham Heart Study. The FRS calculation is dependent upon traditional CHD risk factors: age, total and high density lipoprotein (HDL) cholesterol, systolic blood pressure and treatment, and smoking status. However, numerous studies have documented that the FRS under- or overestimates CHD in populations exhibiting different demographics than the Framingham Heart Study population (1,2).

NASA currently uses FRS to assess the 10-year risk for CHD in astronauts. However, the demographics of the U.S. astronaut corps differ greatly from the Framingham Heart Study population. Furthermore, astronauts experience unique exposures during spaceflight training and participation that could affect their cardiovascular health. Currently, it is difficult to determine the accuracy of the FRS in predicting the 10-year CHD risk in the astronaut corps due to the small number of CHD events. However, given the unusual demographic profile and unique exposures of this study population, NASA medical personnel have determined the need to develop a predictive model specific to U.S. astronauts. This analysis provides some evidence that risk factors traditionally used to predict CHD in the general population may lack the ability to predict CHD events in astronauts. Furthermore, the article discusses imaging techniques that are being considered for inclusion in the new predictive model in an effort to add sensitivity and specificity. This material was presented at a poster session at the Kelsey-Seybold Foundation's 10th Annual Health Services and Outcomes Research Conference, December 2009.

Study Population & Data Collection

All U.S. astronauts (n=321), from the first selection class of 1959 through the selection class of 2004, were included in this analysis. Women were first selected into the US astronaut corps in 1978. The selection criteria for acceptance into the astronaut corps has evolved since 1959, but candidates generally have been screened for appropriate expertise, education, and overall health (3). Payload specialists, international partners, and other space flight participants were excluded from

these analyses due to lack of outcome data. Death certificate searches were conducted to ascertain vital statistics and cause of death through April 2009. Information on demographic and health characteristics collected at baseline and last physical were obtained from medical records and lifestyle questionnaires (Table 1). The outcome was defined as hard coronary heart disease events, including CHD-related deaths or MIs.

Analyses

Low density lipoprotein (LDL) and HDL levels, systolic and diastolic blood pressure, and resting pulse were evaluated as predictors of CHD death or MI using exploratory, multivariable Cox proportional hazards regression modeling. The proportional hazards assumption was checked using log-cumulative hazard plots. Each factor was initially evaluated in a univariable model. A backward stepwise model building strategy was utilized to identify significant predictors of CHD hazard over time ($\alpha=0.10$) (Table 2).

Of all the traditional CHD risk factors examined in this study, only low-density lipoprotein level at baseline is a significant predictor of CHD death or

Table 1. Frequency distributions of selected characteristics of astronauts

Variable		Overall (n=321) No. (%)
Age at selection		
	<35 years	176 (54.8)
	≥35 years	145 (45.2)
Sex		
	Male	276 (86.0)
	Female	45 (14.0)
Race		
	Non-Hispanic white	293 (91.3)
	Other	28 (8.7)
Marital Status		
	Married	262 (81.6)
	Unmarried	59 (18.4)
Educational Level		
	Bachelors	54 (16.8)
	Masters	161 (50.2)
	Doctoral	106 (33.0)

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Table 2. Cox proportional hazards regression analysis results showing univariable (A) and multivariable (B) results

Characteristic*	Hazard Ratio (95% CI) (n=321)
Panel A	
Low-density lipoprotein (per 5mg/dl increase)	1.10 (1.02-1.18)
High-density lipoprotein (per 5mg/dl increase)	0.80 (0.60-1.06)
Resting pulse (per 5 beat increase)	1.19 (0.81-1.75)
Systolic blood pressure (mmHg)	1.05 (0.98-1.14)
Diastolic blood pressure(mmHg)	1.06 (0.95-1.18)
Panel B	
Low-density lipoprotein (per 5mg/dl increase)	1.11 (1.03-1.20)
Resting pulse (per 5 beat increase)	1.29 (0.88-1.91)

Note. Further adjustment for race, education, and sex has no effect on the Hazard Ratios presented; race, education, and sex are not predictive of CHD over time in our study population.

*Characteristic measured at baseline unless otherwise indicated.

MI in the U.S. astronaut corps. It appears that for every 5mg/dl increase in LDL, there is an approximate 10% increase in CHD death or MI risk over time (Hazard Ratio: 1.10; 95% CI: 1.02-1.18). Refer to Table 2. While these results may be due in part to inadequate statistical power, it is also plausible that the astronaut corps is so different from the general population that more sensitive, non-traditional measures are needed to assess CHD risk appropriately, consequently directing clinical practice guidelines.

Further collection of data on CHD risk factors and outcomes in the astronaut corps is vital both for the development of a new predictive model to assess CHD risk and for increasing the statistical power of existing risk assessments. Moreover, including imaging measures as part of the astronauts' standard clinical care regimen will provide more comprehensive information for use in the development of new CHD risk assessment strategies.

Developing a very sensitive and specific predictive model using traditional and non-traditional risk factors to assess astronaut CHD risk is a high priority for space medicine. This new model will be developed specifically for use in the U.S. astronaut corps and can thus maximize predictive accuracy in this unique population,

potentially incorporating occupational exposures and other specific factors that may not necessarily be relevant to the general public. The importance of such a model would be that it could help determine the healthiest astronauts for participation in long duration missions (such as missions to Mars) and thus, could help prevent CHD events from occurring in space during such missions.

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Risk of Atrial Arrhythmias in the Astronaut Corps

BY: SARA MASON

In January 2010, the JSC Space Medicine Advanced Projects Section hosted an Atrial Arrhythmia Summit (1), bringing together medical experts from the fields of cardiology and electrophysiology to review atrial arrhythmia incidence in the astronaut corps. Unique factors which may contribute to atrial arrhythmias in the astronaut corps were identified. Recommendations for screening and treatment were discussed along with implications for spaceflight.

Since the start of the American manned space flight program, 17 cases of atrial arrhythmias have been identified. This equates to 5% prevalence in the astronaut corps, both active and retired, which is consistent with the prevalence of atrial arrhythmia in the general U.S. population. While the risk of developing atrial arrhythmias is not generally increased in the overall astronaut corps, when stratified by age the prevalence among younger members (early to mid-40s) of the astronaut corps was notable and greater than would be predicted based on the general U.S. population. This increase in prevalence may be due in large part to increased screening. Most cases were diagnosed during routine testing, and not related to any report of symptoms (1).

Factors which may contribute to atrial arrhythmias include gender, high vagal tone, hypertension, and alcohol consumption. Prevalence of atrial arrhythmias in the general population is higher in males, and since the astronaut corps is predominantly male (86%) this could contribute to the observed prevalence. Another factor which may contribute is high vagal tone (1). Vagal tone refers to vagal (vagus nerve) control over resting heart rate, resulting in lowered heart rate. High vagal tone is characteristic of high endurance athletes, and the association between vigorous exercise and the early development of atrial fibrillation has been well established (2, 3, 4, 5). In one meta-analysis, intense aerobic exercise greater than 3.3 hours per week increased the risk of developing atrial arrhythmia. However, exercise in terms of long term overall cardiovascular health are protective (1, 2, 3, 4, 5).

Undiagnosed hypertension is associated with 25% of lone atrial arrhythmias, i.e. no identifiable underlying condition, in the general U.S. population. Following a diagnosis of atrial arrhythmia, careful monitoring of blood pressure was recommended by the Atrial Arrhythmia Summit panel to ensure an underlying condition was not overlooked. Excessive alcohol consumption has also been associated with atrial fibrillation. However, there is no evidence of a relationship of alcohol consumption with the atrial arrhythmia cases seen to date in the astronaut corps.

Space flight itself poses a minimal risk to developing atrial arrhythmias. Fluid shifts could cause atrial distension, but the panel members thought the in-flight changes are not significant enough to be considered a serious risk. Activation of sympathetic nervous system during stressful events poses another risk.

Minor arrhythmias during flight are not uncommon (6). As on the ground, arrhythmias are observed during testing and the crewmembers are typically asymptomatic. If asymptomatic arrhythmias were to occur, such arrhythmias could be treated in-flight, although a crewmember who was hypo-tensive or in heart failure would have to return to earth for treatment.

Ablation is the standard treatment for atrial arrhythmias and is considered a cure in the majority of cases. Current JSC Space Medicine clinical guidelines require a 6 month postponement of training after ablation. At 12 months post-ablation, an astronaut is again eligible for space flight participation (1).

While a current diagnosis for atrial fibrillation is cause for disqualification during selection, screening and treatment of atrial arrhythmias that develop later in an astronaut's career are a priority. The panel of experts from the Atrial Arrhythmia Summit agree any history of atrial fibrillation or flutter should be cause for disqualification during selection, since a history of atrial arrhythmias increases the risk of developing future arrhythmias (1). The panel also concurred with the existing JSC

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Space Medicine guidelines for active astronauts and emphasized rigorous monitoring during recovery and training.

Other recommendations from the panel included enhancing current screening protocols of the active corps. Literature suggests certain parameters should be measured to assess risk, like increased left atrial diameter and certain ECG conduction delays, which may be more indicative of the risk of developing atrial arrhythmias in the astronaut corps (1, 2, 3). Changes to the treadmill protocol, more rigorous monitoring of hypertension, and an increase in the duration and sensitivity of Holter monitoring were also among the suggestions resulting from the summit (1).

The Atrial Arrhythmia summit and summary report provided valuable information regarding the risk of atrial arrhythmias in the astronaut population and the identification and treatment of new cases. This review will assist in shaping clinical care guidelines to ensure the safety and health of all astronauts during training, space flight, and beyond.

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