THE LONGITUDINAL STUDY OF ASTRONAUT HEALTH

LSAH Newsletter

December 1999 Volume 8 • Issue 2

Injury Rate of Shuttle Astronauts

Astronauts must undergo rigorous training to prepare for a mission. This training involves not only general physical fitness, but also specific mission-related tasks (*e.g.*, extravehicular activity). It is reasonable to expect an increased rate of injuries, especially musculoskeletal ones, as compared to outside the training period because of the elevated level of physical activity. In addition, the postflight injury rate of astronauts is also of interest, as astronauts will most certainly be in a state of marked deconditioning after prolonged weightlessness. Such suboptimal physical status, when combined with the physiologic changes that occur inflight, may contribute to astronaut injuries involving the musculoskeletal system. Longer periods of spaceflight induce even greater changes. Undoubtedly, such changes will become more problematic as manned spaceflight increases in duration with the development of the International Space Station.

Medical records of astronauts with Shuttle exposure were examined for ICD-9 codes of injuries (which includes fractures, sprains, strains, and open wounds), joint derangements, or disorders of ligaments and muscular attachments. Events falling under this definition were compiled to come up with the overall injury rate, the mission period rates, and injury rate for events occurring outside the training period. For comparison purposes, medical records of the comparison participants were also examined for similar events.

Astronauts with Shuttle exposure were defined as those selected for the Shuttle program, along with those who were selected prior to the program but who flew on Shuttle missions. The overall injury rate included astronauts who have not flown on the shuttle. Mission period analyses encompassed only those who flew between the April 1981 STS-1 and January 1998 STS-89 missions. The mission period was defined as the 1 year preflight and 1 year postflight periods, or a total of 2 years surrounding a mission. The medical data were obtained from periodic clinic visits, annual examinations, preflight and postflight examinations and consultant reports between January 1978 to March 1999. Only events occurring during the astronauts' active duty were considered in these analyses.

The overall injury rate for the shuttle astronauts was markedly greater than the rate for the comparison participants (Table 1). This should not be surprising, as astronauts tend to be more physically active and are therefore more likely to sustain exercise related injuries, despite the fact that they are in a state of improved conditioning. Also, as compared to the astronauts' records, some under-reporting of comparison participant injuries is expected, as the JSC clinic is not the primary care provider for most users. Medical screening and routine care for the

'Injury Rate' continued on page 4

Colorectal Cancer Incidence of LSAH Participants

Colorectal cancer, cancer of both the colon and rectum, is the third most common type of cancer among both men and women in the United States. The American Cancer Society predicts that there will be 129,400 new cases diagnosed this year alone resulting in 54,900 deaths. Though many individuals with colon cancer or some form of benign neoplasm — new or abnormal tumor or growth — are asymptomatic, those with symptoms may experience rectal bleeding, blood in the stool, or a change in bowel habits.

Though everyone is at risk of developing colon cancer, certain factors put some at a greater risk than others. The most important risk factor is increasing age. Individuals age 65 and older make up 73% of all newly diagnosed colorectal cancer cases. Other important risk factors include a family history of colorectal cancer, personal medical history of polyps or inflammatory bowel disease, and a diet high in animal fats. Men and African Americans have a higher incidence and mortality rate as compared with women and other ethnic groups. Factors that may decrease the risk of colorectal cancer include a diet high in fruits and vegetables, regular physical activity, hormone replacement therapy in postmenopausal women, and regular aspirin use.

Modern technology has increased the opportunity to prevent and control invasive disease. These modern techniques have reduced the incidence and

'Colorectal Cancer' continued on page 3

The Flight Medicine Clinic Enters the 21st Century

Congratulations to the CMIS Project Team and the Flight Medicine Clinic! On August 25th, the Flight Medicine Clinic began using Logician™ as the medical record for its patients. Logician, an electronic medical record (EMR), is the foundation of the Comprehensive Medical Information System (CMIS).

Preparations for CMIS began over 3 years ago. The goal of the CMIS project is to integrate medically related data from the various sources of Medical Operations into a single system electronic format. This allows optimal storage, security, and processing and retrieval of medical information and clinic visits. Logician™ was selected over a year ago as the EMR core of CMIS. The CMIS team (flight surgeons, nurses, computer programmers, epidemiologists, systems experts, clinic staff) set its goal to "go live" with Logician by the end of August 1999. Literally thousands of hours by this team during the past six months enabled the merging of Logician with the typical workflows of the Flight Medicine Clinic.

Additional plans for CMIS include:

- Linking to the epidemiology database of the LSAH.
- Linking to the clinical laboratories at JSC
- Linking to digital storage systems for items such as photographs and electrocardiograms
- Modification to improve real-time mission medical support
- Improvement of clinical metrics, trends and tracking, and analytical capabilities.

The CMIS network is located in Building 8. It is based on a Windows NT server, with client computers located in the Flight Medicine Clinic. It is separate and isolated from the JSC InterNetwork, and the users have unique network and application passwords. User access is customized and limited by the unique roles of each user (*i.e.*, doctor, nurse, receptionist, *etc.*).

How will your next visit to the flight surgeon be different? Well, let's pretend: You have come down with a persistent sinus headache, drainage and sneezing. Your ears feel full, and you know that its time to visit your friendly flight surgeon. You walk into the Flight Medicine Clinic, and you are greeted cheerfully. But today, you are asked to have your picture taken; it now appears on page 1 of the EMR. You are registered directly into Logician. The EMR simultaneously notifies the nurse and the flight surgeon that you've arrived. Another workstation is located in the exam room. Your electronic chart is opened, your vital signs are measured and data entered, and your history is updated in the EMR. Simultaneously, the flight surgeon can look through your electronic chart at the workstation in his or her office. As the flight surgeon sees you, new findings can be incorporated real-time. Prescriptions, medications, allergy updates, diagnoses become part of your EMR immediately. Logician will do a cross check with your new medications for side effects and allergies. Medical reference hand-outs about diagnoses or medications can be printed immediately. For follow-up on tests or visits, Logician provided a tracking system and as new data arrive to Logician, clinic staff can send notification flags to the flight surgeon via Logician's internal email.

In 2000, Logician will be employed in the JSC Occupational Medicine Clinic. LSAH comparison participants and other JSC employees will be part of this new venture. ■

Breast Cancer Awareness

Breast cancer is a malignant tumor that has developed from cells of the breast. After skin cancer, it is the most common cancer among women. Current statistics show that one in eight or nine American women will develop this disease at some point in their lives based on full life expectancy.

There are different types of breast cancer, determined by the origin of the cancer cells within the breast. In its early noninvasive stage, cancer cells are found inside the ducts (milk passages connecting the milk-producing glands and the nipple) but have not spread into the fatty cells of the breast, and is called ductal carcinoma in situ (DCIS). In latter stages, the cancer cells have infiltrated the fatty breast tissue from the duct (infiltrating ductal carcinoma), and can potentially metastasize to other parts of the body. This is the most common type of breast cancer, comprising about 80% of breast cancer cases. Other less common types of breast cancer include infiltrating lobular carcinoma (originating in the milk-producing gland) and medullary carcinoma (in

'Breast Cancer' continued on page 3

'Colorectal Cancer' continued from page 1

mortality possibly due to increased screening and subsequent polyp removal. Screening is recommended beginning at age 50 for both men and women of average risk and before age 50 for individuals with a strong family or personal history of colorectal cancer. The American Cancer Society recommends three basic screening options. One option is the combination of Fecal Occult Blood Test (FOBT), Digital Rectal Exam (DRE), and sigmoidoscopy. Normal test results require an annual repeat FOBT and a sigmoidoscopy every 5 years. Another option is the colonoscopy and DRE. Normal results require a repeat test every 10 years. Finally, there is the double-contrast barium enema and sigmoidoscopy combination. Normal results require a repeat exam every 5-10 years.

Astronauts are screened at selection and during the annual examinations. Comparison participants are screened biannually; however, they have the option to decline sigmoidoscopy. Medical records from 1959 until February 1999 were examined for ICD-9 codes corresponding with benign neoplasms and a history of malignant neoplasms of the large intestine, rectum, and anus. Of the 295 U.S. astronauts, 5 individuals (1.7%) were diagnosed with benign neoplasms at selection and 44 individuals (14.9%) were diagnosed after selection. The average time between selection and diagnosis was 18.4 years. Of the 899 comparisons in the database, 39 (4.3%) were diagnosed with benign neoplasms or a history of malignant neoplasms with an average time of 20.6 years between selection and diagnosis. The higher number of diagnoses for the astronaut group compared to the comparison participants corresponds to the higher intensity of medical care available to the astronauts. However, the average time between selection and diagnosis does not differ much between the two groups.

Technological advances have given us the tools necessary to detect and prevent this possibly fatal disease. Detection in its earliest stage has shown a 5 year survival rate of 91%; however, a regional cancer spread has a survival rate of 63%, and metastases to distant parts of the body has only a 7% survival rate. All LSAH participants are encouraged to comply with American Cancer Society screening recommendations to help reduce the incidence and mortality of colorectal cancer. Additional information can be obtained by contacting the American Cancer Society at 1-800-ACS-2345 or www.cancer.org. ■

'Breast Cancer' continued from page 2

which there is a relatively well defined boundary between tumor and normal tissues).

The prognoses and treatment options for breast cancer also vary depending on the type and stage of the disease. Currently, treatment includes both local therapy (*e.g.*, surgery and radiation therapy) directed at the primary tumor, and systemic therapy (*e.g.*, chemotherapy, hormonal therapy) which circulates drugs and hormones through the bloodstream to reach cancer cells that may have metastasized. In general, in situ carcinomas (where the cancer cells have not spread into the fatty cells of the breast) have good prognoses and are treated with surgery followed by chemotherapy. The cure rate for DCIS is close to 100%. Latter stages of carcinomas usually require radiation therapy in addition to surgery and chemotherapy, to destroy remaining cancer cells.
There are several risk factors associated with this disease, including:
Aging - the risk of developing breast cancer increases with age. About 77% breast cancer cases are diagnosed in women over age 50.
Genetic - about 10% of breast cancer cases are hereditary, caused by inherited mutations of the BRCA1 and BRCA2 genes. 50 to 60% of women who inherited such mutations will develop breast cancer by the age of 70. The p53 tumor supressor gene has also been implicated in familial breast cancer. However, most gene mutations leading to breast cancer occur during a woman's lifetime, rather than inherited, and the cause of these mutations is still unknown.
Family History - a woman's risk of developing breast cancer increases if a first-degree relative (mother, sister, daughter) has had the disease, or if two or more close relatives (cousins) have had the disease.
Personal History - women who have had cancer may develop it again. Also, women with cancer in one breast have a 3- to 4-fold increased risk of developing cancer in the other breast.
Lifestyle Factors - women who have no children or their first child after age 30 face a slightly higher risk of breast cancer. The effect of other factors such as obesity and high-fat diets, hormone replacement therapy, and physical activity on risk is currently under investigation.

There is no sure way to prevent breast cancer. However, by reducing the risk factors whenever possible and following early detection guidelines, a woman greatly promotes her chances of overcoming breast cancer. Breast self-examinations starting from age 20, and screening mammography after age 40 are the recommended secondary prevention measures. Additionally, tamoxifen may help prevent breast cancer in women with familial history of the disease. This anti-estrogen drug is currently used to reduce the risk of breast cancer recurrence, but its effectiveness in preventing cancer development is being evaluated. ■

'Injury Rate' continued from page 1

comparisons is much less intensive as compared to the astronauts. In addition, medical care for comparisons received outside of the JSC clinic may not necessarily be included in the LSAH database.

The astronaut injury rate within the mission period was almost three times that of the overall astronaut injury rate, while outside the mission period their injury rate was about half the overall rate (Table 1). The difference between the injury rates inside and outside the mission period was statistically significant (p=0.000). This trend fits the previous expectation of increased injury rates due to more physical activity in the preflight training period as well as the deconditioning of bones and muscles in microgravity.

Shuttle astronauts sustained injuries at a much higher rate than those sustained by the comparison participants. A higher injury rate is to be expected because astronauts, as compared to the comparisons as well as the population as whole, tend to be physically more active, and many participate in regular vigorous exercise. There may also be more complete documentation of injuries in astronauts' medical records. However, in the time period surrounding a mission, the astronaut injury rate is significantly higher as compared to outside of the mission period. Training for a mission, or physical deconditioning following spaceflight may contribute to this higher rate.

There was no difference in the injury rate between the preflight and postflight periods. However, in examining specific musculoskeletal injuries (excluding open wounds and all injuries at other sites), more neck and ankle injuries were sustained in the preflight period and more back injuries were reported postflight. The increased number of postflight back injuries is noteworthy and may be attributable to several factors, including deconditioning, failure of the musculoskeletal system to return to its preflight baseline, not adopting precautionary measures when lifting, or a combination of factors. The relationship between back injuries and spaceflight is difficult to ascertain, as back injuries are such a common problem.

As the actual number of injuries within the mission period was relatively small, the question of whether preflight training or postflight deconditioning contributes more to injuries is yet to be definitively answered. Postflight preventive measures could include a heightened sense of awareness, additional physical therapy for back strengthening purposes, and standard injury precautions. These measures, and others, may be of benefit by decreasing the number of postflight injuries. As more data are gathered, the distinction between the preflight training and postflight deconditioning effects on injuries may be better understood. ■

Table 1. Overall Injury Rates for Comparison Participants and Astronauts

Participant	Injury Rate (per 100 person years)	Number of Injuries
Comparisons	1.3	187
Shuttle Astronauts	13.4	305
Outside Mission Period	7.7	143*
Inside Mission Period	38.6	152*

* These numbers only include astronauts who flew on a shuttle mission between April 1981 and January 1998

Table 2. Shuttle Astronauts Musculoskeletal Injuries at Selected Sites*

	Preflight Number of Injuries	Postflight Number of Injuries
Neck	7	2
Back	4	9
Shoulder	5	4
Hip	2	1
Knee	7	5
Ankle	11	4

*Excludes open wounds and injuries at other sites

For your information ...and ours

If you want a copy of your exam results, please complete and sign a release form while you are visiting the Clinic for your examination. The form is called *Privacy Act Disclosure Authorization and Accounting Record (DAAR)*, or NASA Form 1536.

If you have a new address or phone number, please let us know by calling (281) 244-5195 or (281) 483-7999. You may also write us at:

Longitudinal Study of Astronaut Health
Flight Medicine Clinic/SD26
Johnson SpaceCenter/NASA
2101 NASA Road 1
Houston, Texas 77058-3696

or e-mail us at:
mwear@ems.jsc.nasa.gov