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THE LONGITUDINAL STUDY OF ASTRONAUT HEALTH

# Newsletter

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## Kidney Stones

By **BABY DJOJONEGORO, MS, MPH** AND **JEFFREY JONES, MD, FLIGHT SURGEON**

### What are kidney stones?

**K**idney stones or, more precisely, urinary calculi begin as crystals developing inside kidneys from an excess concentration of minerals in urine. Kidneys function to remove excess fluid and waste from the body in the form of urine, which flows down the ureter toward the bladder and then is voided out. Normally urine contains chemicals inhibiting the formation of mineral crystals, but kidney stones form when this process is not successful, or the levels of inhibitors are not sufficient. When the mineral content exceeds its

ability to dissolve in water (*i.e.*, reaches a supersaturated state) then a precipitate of that mineral may occur.

About 80% of kidney stones are made up of calcium in combination with oxalate or phosphate, which are common minerals in the body. Another common stone component is uric acid or urate. Other rarer types include struvite (magnesium ammonium phosphate), which occurs when the urine is infected with bacteria and cystine stones, which are caused by a genetic disorder. When urinary calculi are confined to the kidney, they may produce no symptoms in some patients but cause back pain and

nausea in others. Tiny stones (< 3 mm) can travel through the ureter and pass out of the body in the urine without notice. However, a stone measuring 3 mm or more can block the flow of urine through the ureter, causing pain in the urinary tract due to distension. Other symptoms such as nausea and vomiting, a persistent urge to urinate, and blood in the urine may also occur.

### Who gets kidney stones?

In the U.S., kidney stones affect up to 10% of males and 5% of females. In 2000, there were 2.7 million kidney

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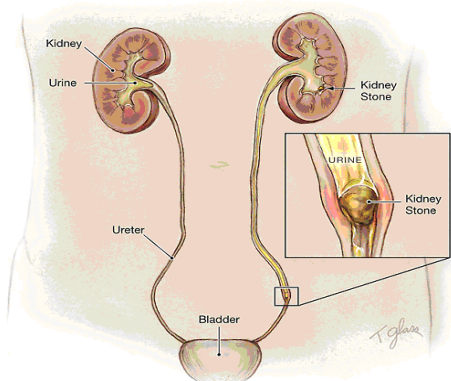
## Screening Treadmills Work

By **BABY DJOJONEGORO, MS, MPH**

**A**n LSAH comparison participant graciously agreed to share his story of how a test he underwent as part of the LSAH protocol saved his life. This spring he came in for a scheduled exercise treadmill test (ETT, see sidebar), which in his case was conducted under the

supervision of Dr. Christine Morgan and registered nurse Susan Siegel of the Occupational Medicine Clinic (OMC). He stated that Dr. Morgan showed keen interest in the electrocardiogram (ECG) readings, conferring with the nurse during the initial phase. Then, during the exercise phase, she asked him to continue a little longer so she could continue monitoring the ECG. Immedi-

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*“Kidney Stones”, continued from page 1*

stone-related visits to health care providers. Risk factors associated with this disease are as follows:

- Gender and age – men are more likely to develop kidney stones than women, especially as they enter their forties and on through their seventies, whereas women’s prevalence peaks when they are in their fifties. Although stones can occur at any age, they are uncommon before age 20.
- Family or personal history – an individual is more likely to develop a kidney stone given a prior history of one or if there is a family history of kidney stones.
- Some diseases – common conditions such as chronic urinary tract infections, anatomic abnormalities such as medullary sponge kidney, or rare genetic disorders such as renal tubular acidosis can lead to a higher likelihood of kidney stone formation.
- Certain medications – taking diuretics or a protease inhibitor may increase the risk of kidney stones.

Astronauts are also at higher risk of developing kidney stones during or after spaceflight because the bone and muscle loss in microgravity leads to excess calcium and minerals in their bloodstream and eventually kidneys. Compounding this is the fact that astronauts usually drink less water while on orbit. Other potential contributors to stone formation include acid load and nanobacteria, but these are under research to define their possible roles. Research is ongoing to evaluate possible means to

reduce the risk of stone formation for space travelers, including testing the efficacy of potassium citrate, a common preventive treatment for kidney stones terrestrially, and exploring the effect of exercise on urinary calcium level.

There have been 14 urinary stone events in 12 U.S. astronauts, with 9 events occurring in 7 crewmembers following spaceflight. There has been one urinary stone during a spaceflight in the Russian program, although a stone was not recovered from that episode (Pietryzk, Jones, Whitson et al, Aviation, Space, and Environmental Medicine, in press). In comparison, a total of 27 comparison participants reported having single or multiple episodes of kidney stones.

### **How are they treated?**

The most conservative treatment of kidney stones involves drinking a copious amount of water (two to three quarts a day) to help wash the stones through the urinary tract. If the patient is vomiting, the excess fluid can be introduced intravenously. This hydration therapy may be accompanied by analgesic and anti-nausea medication if the symptoms are severe. For those suffering from lower ureteral stones under a certain size, a noninvasive approach by using medication to facilitate the passage of the stones may be used. Typically the stones are held in the ureter, and hence produce symptoms caused by the tightening (or spasm) of the smooth muscles of the ureter. Therefore, the use of certain medications which relax muscle or blood vessel walls such as tamsulosin or nifedipine will allow the stones to continue their passage through the lower urinary tract harmlessly. If the stones are too big to be treated in this manner, then

a common nonsurgical treatment called extracorporeal shock wave lithotripsy (ESWL) may be used. In ESWL, shock waves are applied from outside the body, but focused on the calculus to break it apart into smaller pieces. Although noninvasive, this method still may cause bruising and discomfort in the affected area, along with some blood in the urine. Sometimes surgical methods are necessary when the patient’s anatomy, or size or position of the stones renders ESWL ineffective. In percutaneous nephrolithotomy, a surgeon removes the stone from the kidneys using a nephroscope passed through a small incision in the back. Though this method usually involves hospitalization, it allows for direct removal of stones instead of relying on their natural journey down the urinary tract. Another method is to approach the stones from the lower urinary tract employing ureteroscopy. The ureteroscope is passed through the urethra into the bladder, through the ureteral orifice, and into the ureter or even up into the kidney collecting system to locate the stone, which is then captured or shattered with mini-shock waves, ultrasound or laser.

### **What is next?**

Kidney stone treatment has greatly improved over the years, so that major surgery to remove stones is not necessary in most cases. However, the rising prevalence of kidney stones underscores the need to better understand this condition. Research conducted under the auspices of the National Institute of Diabetes and Digestive and Kidney Diseases includes looking into contributing factors to kidney stone recurrence, natural substances in urine which

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# Behavioral Health and Spaceflight

By **STEVE VANDER ARK, PHD**  
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**B**ehavioral health is an important concern of the Space Medicine Division's goal to optimize the health, fitness, and well being of flight crews and their dependents. The Behavioral Sciences and the Behavioral Health and Performance (BHP) Sections have been providing a growing number of services since they were formed at NASA JSC in 1994. They support mission success by optimizing the behavioral health and performance of each astronaut and crew, which includes the family members. Their areas of responsibility include Behavioral Medicine, Operational Psychology, Ground Analog Projects, and Behavioral Research.

## Behavioral Medicine

Behavioral Medicine (BMed) focuses on behavioral health issues for crewmembers and their families. Providing high-quality clinical care is important because behavioral issues can hamper training and flight performance. Providing care also helps NASA better understand the types of problems encountered by astronauts and their families and helps families successfully resolve these problems. This information encourages thoughtful modification of NASA policies to be more helpful to families and the development of preventive health and education programs for families and crewmembers.

The BMed services are also active during a mission through routine conferences with crewmembers, modeled after the Private Medical Conferences (PMCs), and through self-monitoring software and other tools (*e.g.*, the WinSCAT cognitive assessment software) to enable crewmembers to manage their own behavioral health and performance during long-duration missions.

## Operational Psychology

Operational Psychology (OpPsy) focuses on providing psychological support services during flight for long-duration flight crewmembers. The OpPsy team prepares a wide variety of individually-determined items for crewmembers to maintain their behavioral well-being by providing a balance to the hectic work schedule during the mission. Examples of OpPsy services include the following:

- ensuring communication with family and friends is possible through use of 2-way video, e-mail and Internet Protocol phone technologies;
- managing onboard and ground-based websites to provide a central clearinghouse for personal and mission-related information;
- providing items for relaxation such as books, movies, music, personal hobby items, musical instruments;
- arranging communication events with crewmembers' favorite celebrities, educational institutions, friends, etc.;

- providing care packages with goodies from family and friends on every Shuttle and Progress vehicle; soon these will be sent via the ESA Automated Transfer Vehicle too.

Additional family assistance is offered throughout all phases of training, and during and after a mission through the Family Support Office, which is part of the Astronaut Office and BHP Section.

Both OpPsy and BMed services include astronaut training to help crewmembers understand and plan for the psychological demands associated with long-duration flight. Partnering with the Astronaut Office and using such venues as the National Outdoor Leadership School and the Aquarius underwater laboratory, the courses focus on building teamwork, leadership, cross-cultural skills, and self-care/self-management.

## Ground Analog Projects

NASA recently began using the Bed Rest and Artificial Gravity facilities at University of Texas Medical Branch as a high fidelity analog to study the effects of space on the human system. The analog is both physically and psychologically challenging, and requires an extensive screening process in both areas for would-be participants. The BHP Section provides psychological screening services for applicants to this analog. Further, psychological training, monitoring and support services are

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*"Behavioral Health", continued from page 3*

provided to the subjects for the duration of each study.

### Behavioral Research

The space exploration initiative at NASA has increased the focus on behavioral research to help answer operational questions relevant for long-term missions. Within Medical Informatics and Health Care Systems (MIHCS), a Behavioral Research Lead was hired to establish this program of research in concert with Behavioral Sciences. A significant amount of work recently began to identify what we already know from the body of behavioral research evidence, what we need to know, and how to develop a comprehensive plan to fill in the knowledge gaps.

To effectively provide the necessary services requires involvement of nearly every segment of the Space Medicine Division to some extent. The Behavioral Sciences and BHP coordinate closely with Crew Surgeons and BMEs in the Biomed Multi Purpose Support Room for ISS support and monitoring, Space Medicine Training for preflight training requirements, MIHCS for website management, assistance in managing data, and behavioral research, and the Flight Medicine Clinic via an Ombudsman team. ■

*"Screening", continued from page 1*

ately after that, she asked if she could call his private physician, which she proceeded to do while he was still lying down during the recovery phase of the ETT. Apparently the ECG results, which indicated arterial blockage, were serious enough to provoke this reaction from Dr. Morgan.

The comparison participant saw his private physician, who in turn referred him to a cardiologist. Upon consultation, the cardiologist scheduled him for surgery the next day, which coincidentally was his birthday. The procedure revealed two blockages: one was 99% and was treated with a stent (see sidebar), while the second was estimated to be around 30% and is being treated by medication. His cardiologist remarked that if the blockage had not been caught in time, it would certainly have led to a heart attack. Because of that, the participant expressed his extreme gratitude to Dr.

Morgan and LSAH. His cardiologist also forwarded his data to the OMC to ensure continuity of care.

He is currently doing well, passing his first post-surgery treadmill test, with another one scheduled at 6 months. Thanks to his regular participation in LSAH, this participant had a timely intervention for a potentially life-threatening medical condition. ■

### What is a cardiac stent?

A stent is a stainless steel mesh that is left inside a blocked artery to help keep the artery open. The stent is initially collapsed over a balloon catheter, which is then threaded into the blocked artery. When the balloon is inflated, the stent opens and forms a scaffold on the artery wall. Compared to using a balloon catheter alone, using a stent reduces the renarrowing of the affected artery.

*"Kidney Stones", continued from page 2*

block stone formation, and long term effects of lithotripsy. On an individual level, prevention through drinking plenty of water to avoid dehydration is a good first step. Be mindful of

your family history and notify your medical providers of relevant information so they can take the appropriate measures. ■

### For your information

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.

### ...and ours

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:

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