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| **Fiscal Year:** | FY 2005 | **Task Last Updated:** | FY 05/03/2006 |
| **PI Name:** | Whitson, Peggy Ph.D. | | |
| **Project Title:** | Renal Stone Risk During Spaceflight: Assessment and Countermeasure Validation | | |
| **Division Name:** | Human Research | | |
| **Program/Discipline:** | HUMAN RESEARCH | | |
| **Program/Discipline--Element/Subdiscipline:** | HUMAN RESEARCH--Biomedical countermeasures | | |
| **Joint Agency Name:** | | **TechPort:** | No |
| **Human Research Program Elements:** | (1) **HHC**:Human Health Countermeasures | | |
| **Human Research Program Risks:** | (1) **Food and Nutrition**:Risk of Performance Decrement and Crew Illness Due to Inadequate Food and Nutrition<br>(2) **Nutrition**:Risk of Inadequate Nutrition<br>(3) **Renal Stone**:Risk of Renal Stone Formation | | |
| **Space Biology Element:** | None | | |
| **Space Biology Cross-Element Discipline:** | None | | |
| **Space Biology Special Category:** | None | | |
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| **PI Organization Type:** | NASA CENTER | **Phone:** | 281-244-8950 |
| **Organization Name:** | NASA Johnson Space Center | | |
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| **Zip Code:** | 77058 | **Congressional District:** | 22 |
| **Comments:** | | | |
| **Project Type:** | FLIGHT | **Solicitation / Funding Source:** | 96-OLMSA-01 |
| **Start Date:** | 07/01/1999 | **End Date:** | 04/01/2008 |
| **No. of Post Docs:** | 0 | **No. of PhD Degrees:** | |
| **No. of PhD Candidates:** | | **No. of Master' Degrees:** | |
| **No. of Master's Candidates:** | | **No. of Bachelor's Degrees:** | |
| **No. of Bachelor's Candidates:** | | **Monitoring Center:** | NASA JSC |
| **Contact Monitor:** | McCollum, Suzanne | **Contact Phone:** | 281 483-7307 |
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| **Flight Program:** | Shuttle/ISS | | |
| **Flight Assignment:** | ISS Increments 3-10 In flight development phase (data collection has begun) | | |
| **Key Personnel Changes/Previous PI:** | | | |
| **COI Name (Institution):** | Pietrzyk, Robert ( NASA Johnson Space Center )<br>Sams, Clarence ( NASA Johnson Space Center )<br>Jones, Jeffrey ( NASA Johnson Space Center ) | | |
| **Grant/Contract No.:** | None | | |
| **Performance Goal No.:** | | | |
| **Performance Goal Text:** | | | |

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| **Task Description:** | Exposure to the microgravity environment results in many metabolic and physiological changes to humans. Body fluid volumes, electrolyte levels, and bone and muscle undergo changes as the human body adapts to the weightless environment. Changes in the urinary biochemistry occurred as early as flight day 3-4 in the short duration crewmembers. Significant decreases were observed both in fluid intake and urinary output. During and following short duration Shuttle missions, significant changes were observed in the urinary pH, calcium, potassium and uric acid levels. During short duration missions, the risk of calcium oxalate stone formation increased early in the flight, continued at elevated levels throughout the flight and remained in the increased risk range on landing day. The risk returned to preflight levels one week following landing. The preflight calcium phosphate risk was significantly increased early in-flight and remained significantly elevated throughout the remainder of the mission. Results from the long duration Shuttle-Mir missions followed a similar trend. Most long duration crewmembers demonstrated increased urinary calcium levels despite lower dietary calcium intake. Fluid intake and urine volumes were significantly lower during the flight than during the preflight. The calcium oxalate risk was increased relative to the preflight levels during the early in-flight period and continued in the elevated risk range for the remainder of the space flight and through two weeks postflight. Calcium phosphate risk for these long duration crewmembers increased during flight and remained in the increased risk range throughout the flight and following landing. The complexity, expense and visibility of the human space program require that every effort be made to protect the health of the crewmembers and ensure the success of the mission. Results from our investigations clearly indicate that exposure to the microgravity environment of space significantly increases the risk of renal stone formation. These studies have indicated specific avenues for development of countermeasures for the increased renal stone risk observed during and following space flight. Increased hydration and implementation of pharmacological countermeasures should largely mitigate the in-flight risk of renal stones. Maintaining the health and well-being of crewmembers during space flight requires a means of minimizing potential detrimental health effects of microgravity. The formation of a renal stone during flight obviously has severe consequences for the affected crewmember as well as the success of the mission. The studies planned in this investigation will not only provide a better understanding of the stone-forming risk crewmembers experience during and after space flight, but will take the next step to test the efficacy of potassium citrate as a countermeasures to reduce this risk. Based on the known increased risk crewmembers experience, it is imperative that countermeasures to reduce or alleviate this risk are developed and tested. |
| **Rationale for HRP Directed Research:** | |
| **Research Impact/Earth Benefits:** | Relevance to Space and/or Earth Based Research:<br>Previous studies of Skylab and Shuttle crews have demonstrated significant changes in the urinary chemical composition. Increase in urinary calcium and phosphorus are well documented and probably represent bone resorption due to exposure to the weightless environment. Studies of Shuttle mission of varying duration noted significant postflight increases in the urinary stone-forming salts and decreases in the concentration of urinary inhibitors of renal stone formation. This study is expected to show the in-flight effects of microgravity on the risk factors associated with renal stone development. It is expected that space flight will significantly enhance renal stone formation by providing an environment that is saturated with the stone-forming salts, primarily calcium and phosphorus, in the presence of a reduced concentration of renal stone inhibitors. The postflight renal stone profiles completed on Shuttle crewmembers (n = 323) indicated substantial changes from preflight levels and from normal non-stone formers. With the previous in-flight history (n = 6) of some of the known urinary analytes that influence renal stone formation, we expect an increase in calcium-containing stones (both calcium oxalate and calcium phosphate stones), and sodium-containing stones (sodium urate). It is predicted that the increased risk observed during space flight can be minimized and beneficial changes in the urinary chemistry can be accomplished with the use of potassium citrate. Renal stone disease affects approximately 12% of the human population on Earth with recurrence rates of renal stones reaching 75% in untreated individuals. Morbidity is high and related health costs have been estimated to exceed two billion dollars a year. Understanding how the disease may form in otherwise healthy crewmembers under varying environmental conditions may lead to additional clues as to how crystals form in the urine and develop into renal stones. |
| **Task Progress:** | No progress report this period. |
| **Bibliography Type:** | Description: (Last Updated: 04/28/2010) |