Fiscal Year:	FY 2008	**Task Last Updated:**	FY 10/21/2008
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 (2) **Nutrition**:Risk of Inadequate Nutrition (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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City:	Houston	**State:**	TX
Zip Code:	77058	**Congressional District:**	22
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	96-OLMSA-01
Start Date:	07/01/1999	**End Date:**	09/30/2008
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA JSC
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Flight Program:	Shuttle/ISS		
Flight Assignment:	ISS Increments 3-6, 8 and 11-14 (update 5/2007) NOTE: End date is 9/30/2008 per PI and JSC (10/08)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Pietrzyk, Robert (Wyle/NASA Johnson Space Center) Sams, Clarence (NASA Johnson Space Center) Jones, Jeffrey (NASA Johnson Space Center)		
Grant/Contract No.:	None		
Performance Goal No.:			
Performance Goal Text:			

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. The current study evaluated the efficacy of potassium citrate as a countermeasure to reduce this risk. Citrate, an important urinary inhibitor of calcium-containing renal stones binds with calcium in the urine, thereby reducing the amount of calcium available to form calcium oxalate stones. Urinary citrate also prevents calcium oxalate crystals from aggregating into larger crystals and into renal stones. In addition, citrate makes the urine less acidic which inhibits the development of uric acid stones. Potassium citrate supplementation has been successfully used to treat terrestrial patients with recurrent stone formation. The evaluation of potassium citrate as a countermeasure was performed during the ISS Expeditions 3-6, 8, and 11-14. Research Objectives: 1. Quantitate the pre- in- and postflight risk of renal stone formation associated with space flight. 2. Determine the efficacy of potassium citrate as a countermeasure in reducing the in-flight and postflight for renal stone formation. 3. Evaluate dietary impact on the urinary biochemistry. 4. Evaluate the potential benefit of citrate to inhibit bone loss See also http://www.nasa.gov/
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Relevance to Space: Previous data from studies of crewmembers have noted significant in-flight and postflight increases in the urinary stone-forming salts and decreases in the concentration of urinary inhibitors of renal stone formation. Results from this study have indicated that the risk of calcium-containing renal stones can be minimized and beneficial changes in the urinary chemistry can be accomplished with the use of potassium citrate. Strategies to reduce the risk of renal stones should focus on prevention of stone formation and include education of crewmembers, dietary recommendations and pharmacological countermeasures. With humans participating in long duration ISS missions, extended habitation on the moon and exploration class missions to Mars, it is vital to maintain the health, safety and capabilities of all crewmembers.
Task Progress:	Subjects in this study were crewmembers from long duration missions to the International Space Station (ISS). During the 9 ISS missions, 20 subjects (19 male/1 female) participated in this study. Due to in-flight crew constraints 2 male crewmembers on ISS withdrew from the study. The remaining 18 crewmembers successfully completed the study protocol and participated in missions ranging from 93 to 175 days. All in-flight urine samples have been returned to Earth and the urinary biochemistry, dietary and bone marker determination and statistical analysis of the data has been completed. Preparation of the Final Report has also been completed and submitted to the NASA Human Research Program. Development of the manuscript for publication of the final results for submission to a scientific journal is underway.
Bibliography Type:	Description: (Last Updated: 04/28/2010)
Abstracts for Journals and Proceedings	Jones JA. "Urolithiasis in Space." 2nd International Urolithiasis Research Symposium, Indianapolis, Indiana, April 17 - 18, 2008. 2nd International Urolithiasis Research Symposium, Indianapolis, Indiana, April 17 - 18, 2008. , Apr-2008
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Articles in Peer-reviewed Journals	Whitson PA, Pietrzyk RA, Jones JA, Nelman-Gonzalez M, Hudson EK, Sams CF. "Effect of potassium citrate therapy on the risk of renal stone formation during spaceflight." J Urol. 2009 Nov;182(5):2490-6. PubMed PMID: 19765769 , Nov-2009

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Books/Book Chapters	Jones JA, Pietrzyk RA, Whitson PA. "Renal and Genitourinary Concerns." in "Principles of Clinical Medicine for Space Flight." Ed. M.R. Barratt, S.L. Pool. New York : Springer, c2008. p. 273-292., May-2008
Books/Book Chapters	Jones, JA, Sargsyan A, Pietryzk R, Sams C, Stepaniak P, Whitson P. "Urolithiasis and Genitourinary Systems Issues for Spaceflight." in "Renal Stone Disease 2: 2nd International Urolithiasis Research Symposium." Ed. A.P. Evan, J.C. Williams, J.E. Lingeman, J.A. McAteer. Melville, N.Y. : American Institute of Physics, 2008. p. 293-307., Nov-2008