Fiscal Year:	FY 2011	**Task Last Updated:**	FY 05/24/2012
PI Name:	Kassemi, Mohammad Ph.D.		
Project Title:	Integrated Medical Model		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Operational and clinical research		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **ExMC**:Exploration Medical Capabilities		
Human Research Program Risks:	(1) **Medical Conditions**:Risk of Adverse Health Outcomes and Decrements in Performance Due to Medical Conditions that occur in Mission, as well as Long Term Health Outcomes Due to Mission Exposures (2) **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:**	216-433-5031
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Zip Code:	44135	**Congressional District:**	10
Comments:	NOTE (Dec 2019): former affiliation included National Center for Space Exploration Research (NCSER), per information from J. McQuillen/GRC		
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	01/01/2011	**End Date:**	08/08/2014
No. of Post Docs:		**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:	Watkins, Sharmi1a	**Contact Phone:**	281.483.0395
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Flight Program:			
Flight Assignment:	NOTE: Title change to "Integrated Medical Model - Renal Stone Module" per M. Urbina/JSC (Previous title "Probabilistic Analysis of Renal Stones in US Astronauts")--Ed., 10/8/15 NOTE: End date is 8/8/2014, per D. Griffin/GRC (Ed., 5/30/12)		
Key Personnel Changes/Previous PI:	NOTE: Previous PI was Jerry Myers until January 2011. See project with title "Probabilistic Analysis of Renal Stones in US Astronauts" and PI=Myers for previous information		
COI Name (Institution):	Myers, Jerry (NASA Glenn Research Center)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The Exploration Medical Capability Element of the Human Research Program carries the risk of not being able to treat ill or injured crewmembers. Gap 4.13 in the Exploration Medical Capability Research Plan is the “Lack of lithotripsy or other capability to treat a renal stone.” The description of this gap states that, “Given the high probability of kidney stone formation in crew members during long duration missions the capability to perform Lithotripsy is highly desirable.” During all spaceflight missions to date, renal stone incidence is actually lower than what would be expected in the general population or in the analog population utilized by the Longitudinal Study of Astronaut Health. (LSAH). After astronauts return to Earth, however, the incidence rate increases and surpasses both the rate of the general population and the LSAH analog population, with the astronaut incidence rate of calcium oxalate stones approximately doubling that of the general US population. If these trends persist with the reintroduction of even fractional gravity, renal stones during a Mars mission could become a serious problem, not only in terms of astronaut health, but also in terms of the resources required to adequately treat the condition. A Bayesian update analysis of the data above suggested an approximately 5% probability of at least one crewmember developing a renal stone during a Mars mission. Given the nature of these data, the GRC IMM team developed a proof of concept probabilistic simulation of renal stone formation during a long duration exploration mission. While somewhat limited in scope, this simulation included both probabilistic and deterministic components. The deterministic components were developed to support the probabilistic analysis. Key findings from this work included: 1) As the stone grows larger, the governing equation says the rate of growth will increase, which is why the probabilistic analysis picks up the seed size as being influential. 2) The probabilistic model demonstrates identical sensitivity for Calcium and Oxalate, suggesting that a more detailed surface chemistry simulation needs to be conducted. 3) The sensitivities for the dwell time of a stone show pronounced differences between the 2.0L/day and 2.5L/day cases resulting in a 68.6% change in the probability of one stone reaching the effective diameter of a nephron from heterogeneous growth only. This result has a standard deviation of 0.237. As part of the validation process for this module, the task underwent a subject matter expert review of the work done to date. The review was favorable with indication that an increase model fidelity was required, as outlined in Steps 1-3 below. 1. Determine expected incidence rate of renal stones during exploration missions and how this rate is affected by new countermeasure activities. 2. Provide a probabilistic simulation that allows the Exploration Medical Capabilities Element of the Human Research Program to develop medical kits appropriate to the level of risk of renal stone formation. 3. Provide a probabilistic simulation that allows the Exploration Medical Capabilities Element of the Human Research Program the ability to quantitatively evaluate the effect of different operations scenarios on the ability of a given medical kit to adequately treat an ill or injured crew member. The GRC IMM task team is currently working to extend the capabilities of the deterministic model used as the parameter integration function to include both promoters, inhibitors, agglomeration, wall interaction effects and gravity components. Once this is matured, it will be wrapped with a probabilistic simulation representing the scenarios and physiological parameter variation typical of space flight to assess the likelihood of renal stone formation.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research, which requires focused and constrained data gathering and analysis that is more appropriately obtained through a non-competitive proposal.
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2011. Previous PI was Jerry Myers until January 2011. See project with title "Probabilistic Analysis of Renal Stones in US Astronauts" and PI=Myers for previous information
Bibliography Type:	Description: (Last Updated: 03/08/2022)