Fiscal Year:	FY 2020	**Task Last Updated:**	FY 02/20/2020
PI Name:	Hall, M. Kennedy M.D.		
Project Title:	Renal Stone Ureter Management Technology Development and Clinical Validation Study		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:	**TechPort:**		No
Human Research Program Elements:	(1) **ExMC**:Exploration Medical Capabilities		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Seattle	**State:**	WA
Zip Code:	98195	**Congressional District:**	7
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	Directed Research
Start Date:	04/02/2018	**End Date:**	09/30/2020
No. of Post Docs:	2	**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
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2020 as project is complete (original end date was 4/30/2022), per K. Lehnhardt/ExMC (Ed., 12/15/20) NOTE: Start date changed to 4/02/2018 (from 4/24/2019) per K. Lehnhardt/ExMC element scientist (Ed., 2/19/2020)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Wessells, Hunter M.D. (University of Washington) Bailey, Michael Ph.D. (University of Washington)		
Grant/Contract No.:	Directed Research		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	[Ed. note December 2020, per K. Lehnhardt, ExMC Element Scientist: The task is complete and ExMC has received the final report. It ended on Sept 20, 2020.] Kidney stones have long been near the top of NASA's list of medical concerns. With this proposal we are addressing the following gaps from NASA's Human Research Roadmap (https://): Med 12 We do not have the capability to mitigate select medical conditions and Med 13 We do not have the capability to implement medical resources that enhance operational innovation for medical needs. Med 12 and 13 "will: 'Develop the capability to diagnose or treat renal stones in an exploration missions.' and 'Develop the relevant medical capabilities to technical maturity." The risk is that a stone, while innocuous when still in the kidney, will cause debilitating pain as it passes or worse, become obstructing, which can lead to urinary tract infection, sepsis, renal failure, and death. We propose a clinical trial of a countermeasure for this urgent condition which we have developed together with NASA. Stones have plagued humans since ancient Egypt. One in eleven Americans has suffered from stones -- more than have diabetes or cardiovascular disease. Dehydration, stasis, and bone demineralization are strong contributors to kidney stones, and occur in microgravity, increasing the risk of stones in space. Stones are often debilitating, and pilots cannot fly with stones. Science, experience, and the negative medical consequences support concern for the risk of stones in space. NASA has focused considerable attention on stone mitigation and made progress. However, there are many types of stone disease, and it is unlikely that stone disease will ever be completely prevented on Earth or in space. The impact of this project will be to clinically validate the utility of a commercially viable disruptive medical technology for use during space exploration. Application to date has been on expelling stones from the kidney. The proposed work will expand the capabilities of the technology to meet the more advanced needs in space.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research. Due to weightlessness in space, it is believed that astronauts have a higher than normal probability to develop kidney stones. Novel, unique ultrasound technology developed by the University of Washington has been demonstrated to identify and move small renal stones within the kidneys. The next challenge with kidney stones is that they can block the ureteropelvic junction (UPJ) and ureterovesical junction (UVJ) positions of the ureter. This study will demonstrate that the ultrasound technology developed by the University of Washington can move renal stones blocking the UPJ and UVJ junctions thus relieving pain associated with hydronephrosis.
Research Impact/Earth Benefits:	National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) writes (1) "Urinary Stone Disease (USD) is an important health care problem affecting both adults and children, causing pain and suffering for the patient and a financial burden to the Nation. One in 11 Americans now has USD, and the prevalence is increasing (2). According to the NIDDK-funded study, the direct medical cost of USD in the United States is $10 billion annually, making it the most expensive urologic condition (3)." While stones are innocuous in the kidney, obstruction, which occurs when a stone impedes urine flow through the ureter and causes a buildup of pressure in the kidney, is the dominant cause to seek medical attention for stones (4-7). Obstruction leads to severe pain and significant risk (sepsis, kidney loss, death); therefore, relief of obstruction is the primary reason for intervention, hospitalization, imaging, and healthcare expense (4-7). Annually, stone obstruction of the ureter, predominantly at the ureteropelvic (UPJ) and the ureterovesical junction, which are visible locations on ultrasound, results in greater than 1,000,000 annual visits to U.S. emergency departments (ED) (7). There is no simple management solution for obstruction in the acute setting; the physician primarily manages pain and mitigates risks due to obstruction. From a recent urologic textbook: "Stone treatments may not be performed in the acute setting secondary to patient factors (active infection, renal failure, ureteral inflammation/edema) and hospital system factors (operating room, special equipment, and staff availability)." (5) Medical expulsive therapy may be prescribed to facilitate passage, and the patients are discharged to wait and see if the stone will pass. Stone passage from the UVJ takes up to 4 weeks, and frequently includes additional ED visits for pain (8). Despite ED diagnosis and pain control management, 1 in 5 initial stone obstructed patients in the ED are admitted to the hospital to receive an urgent invasive temporary procedure, such as placing a stent or nephrostomy tube, to decompress the kidney (4,7,9). Surgical placement of a stent relieves pain and risk by allowing urine to pass, but does not remove the stone. The patient still undergoes expectant observation or is scheduled for surgery. As such, many patients end up requiring surgical intervention to remove the stone (9). Minimally invasive options include shock wave lithotripsy (SWL) and ureteroscopy laser lithotripsy (URS). Both have surgical risks and can yield pain. Neither is performed in the U.S. at point of care in the emergency department. In our work, we are conducting a clinical trial of a non-invasive ultrasound-based solution to dislodge and reposition an obstructing stone to decompress the kidney, alleviate pain, and avoid hospitalization and urgent surgery. References 1. NIDDK Urinary Stone Disease Research Opportunities and Challenges Workshop, March 2015. 2. Scales CD, Jr., Smith AC, Hanley JM, Saigal CS. Prevalence of kidney stones in the United States. Eur Urol 2012;62:160-5. 3. Litwin MS, Saigal CS. Table 14-47: economic impact of urologic disease. In: Urologic Diseases in America. Washington, DC: National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, Public Health Service, US Dept of Health and Human Services; 2012:486. NIH publication 12-7865. 4. Yan JW, McLeod SL, Edmonds ML, Sedran RJ, Theakston KD. Risk Factors Associated with Urologic Intervention in Emergency Department Patients with Suspected Renal Colic. The Journal of Emergency Medicine 2015;49(2):130–5. 5. Harper JD, Ahn J, Acute Kidney Stone Management in Urologic Emergencies. in Acute Urology, Edit H. Wessells, Publisher: Wiley 2017 in press. 6. Pearle, MS, Calhoun, EA, Curhan, GC. Urologic diseases in America project: urolithiasis. J Urol 2005 March; 173:848-857. 7. Foster G (Social & Scientific Systems, Inc.), Stocks C (AHRQ), and Borofsky MS (New York University). Emergency department visits and hospital admissions for kidney stone disease, 2009. HCUP statistical brief #139. July 2012. Agency for healthcare research and quality, Rockville, MD.

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Task Progress:	This NASA funded study examines the ability of ultrasonic propulsion to dislodge and reposition acute obstructing ureteral stones from the ureteropelvic junction (UPJ) or the ureterovesical junction (UVJ) to relieve pain and obstruction, and/or to facilitate passage. Noninvasive manipulation of obstructing ureteral stones at the bedside would represent a breakthrough in the management of acute renal colic. This is a 20-subject feasibility trial (NCT02028559). Patients presenting to either of two University of Washington Emergency Departments (ED) with an acute obstructing UPJ or UVJ stone are screened for inclusion. Standard of care is not interrupted. Once consented, participants undergo a pain assessment and the investigative procedure using a custom device capable of delivering ultrasonic propulsion for repositioning and burst wave lithotripsy (BWL) for dislodging. Success is measured via two outcomes: 1) movement of the stone, assessed by an independent radiologist blind to the therapy dose, and 2) safety, assessed in terms of prevalence and severity of adverse events associated with the therapy. Secondary outcomes include the reduction of hydronephrosis, the reduction of pain, and the passage of stones. Fourteen participants have enrolled with stone sizes 3-9 mm. Motion was observed in one of two UPJ stone cases and two of eight UVJ stone cases. In four of six propulsion only cases, the UVJ stones passed within 24 hours. In the six UVJ cases with BWL dislodging pulses added, all stones passed within a few days. The fracture of one stone as a result of the dislodging pulses was visible on the ultrasound guidance. All subjects tolerated the procedure well. There were no serious or unanticipated adverse events. All non-serious adverse events were mild and self-limiting, and resolved spontaneously without intervention. No decrease in hydronephrosis was reported during the procedure. Ultrasonic propulsion was observed to move about 1/3 of obstructing ureteral stones. The majority of UVJ stones treated with the investigative therapy passed. The technology may offer an adjunct or option to medical expulsive therapy and analgesics in managing obstructing stones. Randomized trials would be the next step to determine effectiveness and causality. [Ed. note December 2020, per K. Lehnhardt, ExMC Element Scientist: The task is complete and ExMC has received the final report. It ended on Sept 20, 2020. PIs report "The patients tolerated the procedure and several patients passed their stones within 24 hours of our treatment. We also have added to the system capability to break and dislodge stuck stones. These results have helped NASA mitigate a risk of human space exploration."]
Bibliography Type:	Description: (Last Updated: 11/05/2023)
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