Fiscal Year:	FY 2017	**Task Last Updated:**	FY 11/28/2016
PI Name:	Baker, John Ph.D.		
Project Title:	Determination of Risk for and Occurrence of Heart Disease from Space Radiation		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SR**:Space Radiation		
Human Research Program Risks:	(1) **Cardiovascular**:Risk of Cardiovascular Adaptations Contributing to Adverse Mission Performance and Health Outcomes		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	jbaker@mcw.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	414-955-8706
Organization Name:	Medical College of Wisconsin		
PI Address 1:	Congenital Heart Surgery		
PI Address 2:	8701 W Watertown Plank Rd		
PI Web Page:			
City:	Milwaukee	**State:**	WI
Zip Code:	53226-3548	**Congressional District:**	5
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2013-14 HERO NNJ13ZSA002N-RADIATION
Start Date:	01/08/2015	**End Date:**	01/07/2019
No. of Post Docs:	0	**No. of PhD Degrees:**	3
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
Contact Monitor:	Simonsen, Lisa	**Contact Phone:**	
Contact Email:	lisa.c.simonsen@nasa.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	November 2016: There have been no changes to the PI or other key personnel.		
COI Name (Institution):	Kronenberg, Amy D.Sc. (Lawrence Berkeley National Laboratory)		
Grant/Contract No.:	NNX15AD69G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The objective of this application is to determine the increased risk of developing degenerative cardiac disease as a result of exposure to representative components of space radiation. Ground-based animal studies will be used to assess the increased risk for developing degenerative cardiovascular disease. A model of accelerated coronary fibrosis and the degeneration of heart morphology and function following exposure to ionizing radiation, in previously healthy rats, has already been developed and validated. In this rat model, whole body ionizing radiation with single doses of 6-10 Gy of X-rays resulted in clinically relevant changes in cardiac function that can be measured, noninvasively. Our central hypothesis is that whole body exposure to space-relevant doses of solar particle event (SPE) protons and galactic cosmic rays (GCRs) will increase the risk for developing degenerative cardiovascular disease. Three Specific Aims are proposed to directly address the issue of cardiovascular risk using experimental approaches in a rat model and theoretical modeling of disease progression to apply the results from the rat studies to astronauts. The proposed investigations directly address important aspects of the NASA Human Research Program (HRP) Degenerative Tissue Gaps, as set forth in the Human Research Roadmap. HRP gaps are identified that are addressed by each Specific Aim. The proposed research will provide important information to help close these gaps. Specific Aim 1: Determine the progression rates, latency periods, and relative biological effectiveness (RBE) of iron ions, silicon, and protons compared with gamma rays of risk for and occurrence of degenerative disease in the cardiovascular system resulting from ground-based exposure to GCRs and SPEs. (HRP Gaps Degen-1, -2, and -3). Specific Aim 2: Determine the importance of the kidney in the mechanisms underlying cardiac disease from HZE (high energy particles) ion exposure. (HRP Gaps Degen-1, -2, and -3). Specific Aim 3: Develop a theoretical model of disease progression to extrapolate results on charged particle-induced cardiac risks in rats to degenerative cardiac disease in astronauts. (HRP Gaps Degen-1, -5).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This research benefits life on Earth as it relates to patients who receive therapeutic radiation for the treatment of cancer and to individuals who receive accidental exposure to radiation from a nuclear accident.
Task Progress:	This project addresses the following goals set forward in the 2014 NASA Research Announcement (NRA) for Radiation Studies: 1) to provide detailed physiological and bio-molecular characterization of degenerative tissue responses to space-like radiation doses that are mission relevant for future human spaceflight outside low Earth orbit and 2) to determine relative biological effectiveness (RBE) values for space radiations in appropriate animals using relevant intermediate as well as late physiological endpoints and effects. These experimentally derived RBE values to provide quantitative inputs into methods and models to calculate degenerative tissue responses in humans following exposures in space. The central hypothesis of this project is that whole body exposure to space-relevant doses of galactic cosmic rays (GCRs) will increase the risk for developing degenerative cardiovascular disease. Three specific aims are proposed to address the issue of cardiovascular risk using experimental approaches in a rat model and the mathematical modeling of rat and human data relevant to the research questions. Specific Aim 1: Determine the progression rates, latency periods and relative biological effectiveness (RBE) of iron ions, silicon and protons compared to gamma-rays for degenerative disease in the cardiovascular system resulting from ground-based exposure to GCRs. Specific Aim 2: Determine the importance of the kidney in the mechanisms underlying cardiac disease from HZE ion exposure. Specific Aim 3: Develop a theoretical model of disease progression to extrapolate the results for charged particle-induced cardiac risks in rats to degenerative cardiac disease in astronauts. Following irradiation of the rats (n=12 per group) we are determining changes in risk factors for cardiovascular disease and cardiac injury in a longitudinal study. The end points to be measured include total cholesterol, HDL-cholesterol, and triglycerides in blood. These measurements will be made monthly over a 9 month follow up period. We will perform histological studies and cardiac echocardiography studies to measure injury to the heart at the end of the study. We will use this data to determine dose-response relationships for 56Fe, 28Si, and protons as representative ions in GCRs. Male Wistar rats, 6 months of age, have been exposed to 4 doses of 600 MeV/n 56Fe (LET = 174 keV/µm); 0.1, 0.25, 0.5, or 1.0 Gy, 4 doses of 1000 MeV protons (LET = 0.24 keV/µm); 0.25, 0.5, 1.0, or 1.5 Gy, 4 doses of 500 MeV/n 28Si (LET = 54 keV/µm); 0.25, 0.50, 0.75, and 1.5 Gy, and 3 doses of 137Cs; 1.5, 3.0, and 6.0 Gy. Sham-irradiated rats served as controls. Twelve rats were included in each experimental group. There have been no deaths associated with any dose of radiation. Risk factors for cardiac disease (total cholesterol and triglycerides) were unchanged over the 270 day follow period for 56Fe, protons, and 137Cs. Risk factors for cardiac disease were elevated at 30 days after irradiation with 0.25 and 0.50 Gy 28Si compared with age-matched sham-irradiated controls. There were no changes in these risk factors for rats irradiated with 28Si from 60 to 150 days. Kidney injury (blood urea nitrogen and blood pressure) was not elevated over the 270 day follow period for 56Fe, protons, and 137Cs. Blood urea nitrogen was elevated at 30 days after irradiation with 0.25, 0.50, 0.75, and 1.5 Gy 28Si compared with age-matched sham-irradiated controls. There were no changes in blood urea nitrogen for rats irradiated with 28Si from 60 to 150 days.
Bibliography Type:	Description: (Last Updated: 01/29/2024)