Fiscal Year:	FY 2023	**Task Last Updated:**	FY 07/11/2023
PI Name:	Lewandowski, Beth Ph.D.		
Project Title:	Tempus ALS ISS Technology Demonstration		
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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Zip Code:	44135	**Congressional District:**	9
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	Directed Research
Start Date:	08/08/2022	**End Date:**	09/30/2024
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
Contact Monitor:	Lemery, Jay	**Contact Phone:**	
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	Adding Co-I names who have been working on the project: Courtney Schkurko Kimesha Calaway Rachael Miller		
COI Name (Institution):	Lehnhardt, Kris M.D. (NASA Johnson Space Center) Easter, Benjamin M.D. (NASA Johnson Space Center) Suresh, Rahul M.D. (NASA Johnson Space Center) Thompson, Moriah M.D. (NASA Johnson Space Center) Schkurko, Courtney (NASA Glenn Research Center) Calaway, Kimesha (ZIN Technologies, Inc.) Miller, Rachael (KBR, Inc.)		
Grant/Contract No.:	Directed Research		
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Task Description:	The aim of this project is to evaluate the use of the Tempus Advanced Life Support (ALS) device in the spaceflight environment: • In collaboration with the European Space Agency (ESA), Phase 1 entails using the Tempus ALS device, compared to current International Space Station (ISS) medical devices, for the completion of Periodic Health Status exams and ISS medical contingency drills for 6 crewmembers (ESA = 2, NASA = 4), in order to achieve ESA's test objectives as described in the ESA Tempus ALS Technology Demonstration Activity Requirements Document (ARD)1. • NASA-led Phase 2 of the demonstration will entail Exploration Medical Capability (ExMC) and the Exploration Medical Integrated Product Team (XMIPT) working together to demonstrate the use of Tempus ALS on the ISS as part of progressively Earth-Independent Medical Operations (EIMO) through the execution of onboard medical simulations that emphasize crew autonomy during exploration medical care. The Tempus ALS is a multifunctional medical device with capabilities that include vital sign collection and monitoring, communications to enable telemedicine, interfaces with electronic health records, ultrasound, video laryngoscopy, and defibrillation. Tempus for ISS project activities will include evaluation of the usability of the Tempus ALS in a spaceflight environment, its functionality during the diagnosis and treatment of simulated medical conditions, and the increased onboard capabilities that it can provide when operated autonomously. The project results will be used to answer the question: Is the Tempus ALS a good candidate for inclusion within spaceflight medical system operations on exploration missions? For this project, simulations of one or more medical contingency scenarios will be executed and ISS astronauts will be required to follow and perform the NASA and ESA developed medical procedures necessary for diagnosing and treating the medical emergency. The astronauts will be required to use several of the capabilities of the Tempus ALS device while performing these procedures. The astronauts will perform the procedures under varying levels of autonomy, including with and without communication delays and with different types of procedural guidance.
Rationale for HRP Directed Research:	This research is directed because it contains highly constrained research. Currently aboard the International Space Station (ISS), NASA has the ability to perform in-flight medical vital signs monitoring, in-flight imaging, and Periodic Health Status exams with a suite of medical devices and techniques. On the ISS, these medical procedures are currently accomplished with reliance on the Flight and Medical Operations teams on the ground. For long-duration space missions, mass, power, and volume requirements for medical devices will be increasingly limited. Further, with increased distance, the Earth-Independent Medical Operations (EIMO) capability will be a cornerstone of the provision of adequate medical care during exploration missions beyond low-Earth orbit (BLEO). There is a need to identify and evaluate medical devices that will be amenable to the EIMO construct.
Research Impact/Earth Benefits:	The Tempus ALS device is designed for operations in pre-hospital and in remote settings. The Tempus ALS consists of two devices, the Tempus Pro (for vital sign measurements and clinical imaging), and the Tempus LS (for atrial defibrillation). The demonstrations of the Tempus Pro device performed during this study will provide additional user experience information as the device is used in the remote and extreme environments of the ISS and the Exploration Atmosphere Chamber. This information could further aid its effective use in other remote and extreme Earth-based environments.
Task Progress:	During fiscal year 2023, several demonstrations of the Tempus Pro device were performed within the NASA Johnson Space Center (JSC) 20 ft Exploration Atmosphere (EA) Chamber during 3-day and 11-day EA Prebreath Validation studies. The environmental conditions within the chamber included a high oxygen concentration (34% O2) and low partial pressure (8.3 psi) atmosphere. Test subjects performed demonstrations with the Tempus Pro during supplemental science sessions scheduled during the non-Extravehicular Activity (EVA) days of the study. Test procedures stepped the participants through operating the Tempus Pro so that the device's various functional components could be demonstrated. During the demonstrations one subject operated the Tempus Pro as "the operator," and took vital sign measurements and medical images from another subject, "the patient." Specific vital sign measurements included electrocardiography, non-invasive blood pressure, oxygen saturation and body temperature. Operators took pictures of the back of the throat with a flexible tip video camera and ultrasound images with an ultrasound probe connected to the Tempus Pro. The heart, bladder, gall bladder, kidney, and aorta were imaged. The images were saved within the Tempus Pro once the anatomy of interest was located, and a satisfactory image obtained. The operator entered notes into the Tempus Pro and saved a record of the measurements onto a universal serial bus (USB) drive. Both the operator and the patient filled out user experience questionnaires, providing feedback on device ease of use and measurement comfort, and a NASA Task Load Index (TLX) workload survey. A medical signal simulator (Pronk Technologies) was used to verify that the Tempus Pro was not damaged, and functionality was not altered due to its exposure to the high oxygen, low-pressure atmosphere. The Tempus Pro readings of the simulator signal were accurate during measurements performed before and after the device was used in the chamber, verifying its survival in the alternate atmospheric conditions. The actual measurements taken with the Tempus Pro were not used for research purposes, they were only used to verify device functionality in the exploration chamber. We observed that all measurements taken with the Tempus Pro were within normal physiological ranges, with no anomalous readings. The user experience and workload surveys are currently undergoing analysis. The demonstrations performed to date with the Tempus Pro indicate that it contains several of the capabilities that are required for an exploration medical system, and it maintains its operational capabilities in alternate atmospheric conditions. Early results from non-medically trained operators of the Tempus Pro found the device intuitive and easy to use. The test subjects acting as patients did not report any excessive discomfort when having measurements taken with the Tempus Pro. Future demonstration plans include the development of test procedures that include medical contingency scenarios that the caregivers must work through to diagnose and treat a simulated medical event. These demonstrations will be performed with and without a communications delay so that the use of a multi-functional integrated medical device, like the Tempus Pro, within an Earth Independent Medical Operations (EIMO) system can be further investigated. Ground-based demonstrations will continue as well as preparations for International Space Station (ISS) demonstrations.

Bibliography Type:	Description: (Last Updated: 06/06/2024)
Abstracts for Journals and Proceedings	Lewandowski BE, Perusek GP, Schkurko CM, Calaway KM, Easter BD, Suresh R, Lehnhardt KR, Thompson MS. "Preparation for an Earth independent medical operations demonstration using the Tempus ALS medical device." Development and Testing of Novel Medical Capabilities for Human Spaceflight. 2023 NASA Human Research Program Investigators' Workshop, Galveston, Texas, February 2023. , Feb-2023