

Extreme Tele-Echocardiography: Methodology for Remote Guidance of In-flight Echocardiography Aboard the International Space Station

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Background: Echocardiography is ideally suited for cardiovascular imaging in remote environments, but the expertise to perform it is often lacking. In 2001, an ATL HDI5000 was delivered to the International Space Station (ISS). The instrument is currently being used in a study to investigate the impact of long-term microgravity on cardiovascular function. The purpose of this report is to describe the methodology for remote guidance of echocardiography in space.

Methods: In the year before launch of an ISS mission, potential astronaut echocardiographic operators participate in 5 sessions to train for echo acquisitions that occur roughly monthly during the mission, including one exercise echocardiogram. The focus of training is familiarity with the study protocol and remote guidance procedures. On-orbit, real-time guidance of in-flight acquisitions is provided by a sonographer in the Telescience Center of Mission Control. Physician investigators with remote access are able to relay comments on image optimization to the sonographer. Live video feed is relayed from the ISS to the ground via the Tracking and Data Relay Satellite System with a 2 second transmission delay. The expert sonographer uses these images along with two-way audio to provide instructions and feedback. Images are stored in non-compressed DICOM format for asynchronous relay to the ground for subsequent off-line analysis.

Results: Since June, 2009, a total of 19 resting echocardiograms and 4 exercise studies have been performed in-flight. Average acquisition time has been 45 minutes, reflecting 26,000 km of ISS travel per study. Image quality has been adequate in all studies, but remote guidance has proven imperative for fine-tuning imaging and prioritizing views when communication outages limit the study duration. Typical resting studies have included 12 video loops and 21 still-frame images requiring 750 MB of storage.

Conclusions: Despite limited crew training, remote guidance allows research-quality echocardiography to be performed by non-experts aboard the ISS. Analysis is underway and additional subjects are being recruited to define the impact of microgravity on cardiac structure and systolic and diastolic function.