ADUM: Advanced Diagnostic Ultrasound in Microgravity

Smridhi, 12th grade
Health Careers High School, San Antonio, Texas

Object of the Mission

- The Advanced Diagnostic Ultrasound in Microgravity (ADUM) mission was designed to:
  - Test the accuracy of diagnosis of on-orbit injuries via ultrasound imaging.
  - Assess the feasibility of ultrasound to monitor in-flight bone alterations.

Description

- Investigation includes:
  - Feasibility of monitoring bone density during long-duration flights
  - Determining health problems in eyes, bones, sinuses, and abdominal injuries
- Nonmedical crew members
  - Given instructional CD ROMS to train themselves
  - Intent is to establish an instructive, simple method to teach medically-untrained professionals to successfully use an ultrasound machine

Principle Investigator

- Scott A. Dulchavsky, M.D., Ph.D., Henry Ford Health System, Detroit, MI
- Co-Investigators:
  - Ashot Sargsyan, M.D., Wyle, Houston, TX
  - Douglas R. Hamilton, M.D., Ph.D., Wyle, Houston, TX
  - Shannon Melton, Wyle, Houston, TX

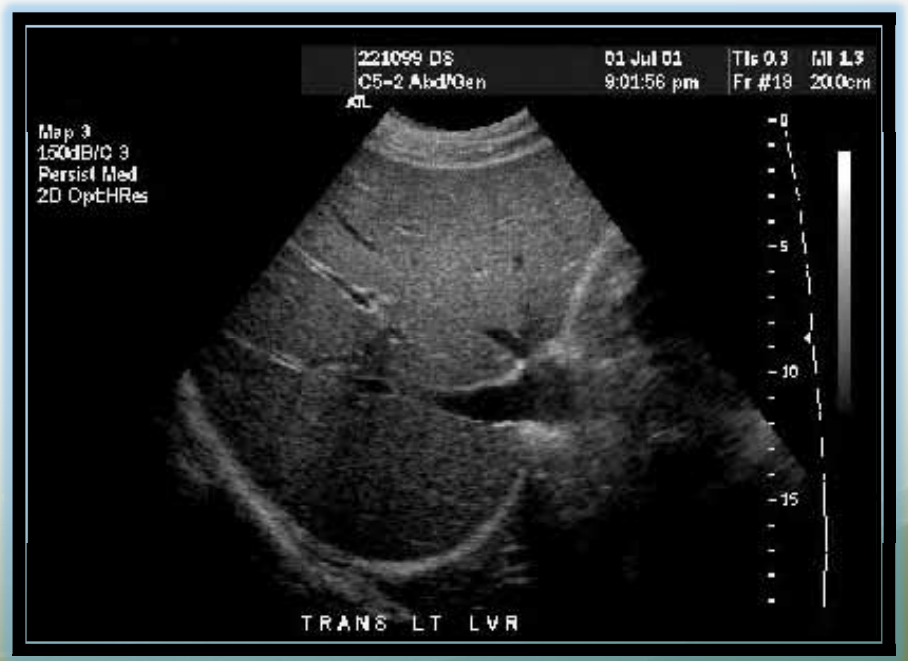
ISS Missions

- Previous Missions
  - ADUM is the first experiment to specifically test the effects of microgravity on ultrasound
    - However, ultrasound equipment was used during Increment 5
- Expeditions Flown: 8 – 12
- Expedition Duration: October 2003 – April 2006

What is Ultrasound?

- Ultrasound imaging, AKA sonography
  - Uses high frequency sound waves to produce real-time structure and movement of the internal organs
  - Non-invasive imaging test that enables physicians to diagnose and treat medical conditions

Ultrasound image of the gallbladder



Ultrasound image of the liver

Significant Importance

- Ultrasound is the only imaging device currently available on the ISS
  - Exploration crews need diagnostic accuracy for evaluation of 250 medical conditions
- Crews working beyond Low Earth Orbit need telemedicine strategies for potential space illnesses

Significant Importance

- In addition, this experiment tests the ability of non-medically trained crew members
  - Examinations were performed with little to no guidance from trained professionals in mission control

Earth Applications

- Using a relatively small diagnostic machine (without the help of a health care worker)
  - Saves lives and reduces healthcare costs
- Long distance communication with doctors
  - Largely efficient way of worldwide medical diagnosis
- Potentially grants universal access to clinical imaging experts

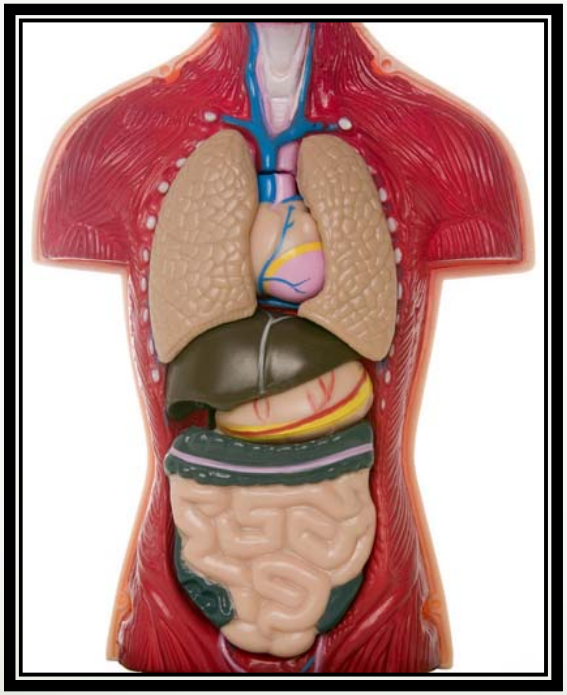
Space Applications

- Minimizes onboard resources while efficiently diagnosing medical problems
- Ability of astronauts to use ultrasound with scarce instruction
  - Encourages thorough treatment and prevents avoidable evacuation
- Enhancing the technology for telecommunication
  - Necessary for long-term and long-duration exploration

Requirements

- Two crewmembers must participate in a scan
  - One serves as the “patient”
  - The other operates the Human Research Facility (HRF) ultrasound machine
- The “patient” must be restrained using the Medical Operations Crew Medical Restraint System
  - Mandatory for all scans, excluding the bone scan
- Required audio/video links must be in private mode for crewmember privacy

Procedures



Total time required: 2 hours

1. Set up the ultrasound system
   - Consists of HRF laptop and ultrasound keyboard, monitor, and probes
2. Scan lasts between 20 and 50 minutes
   - Performs four scan sets:
     1. Cardiothoracic (heart/lungs)
     2. Abdominal (i.e. liver, spleen)
     3. Dental (mouth)
     4. Bone scan (bones)
3. Shut down machine and store supplies

Results

- The ADUM experiment shows that minimal training and the guidance of a certified sonographer produces quality diagnostic images
- Results of the analysis of the crewmembers' pictures/videos by the NASA TeleScience Center are outstanding
- Ultrasound on the ISS requires an onboard proficiency enhancement program, visual cue cards, and guidance from trained radiological personnel on Earth.

Extended Results

- Expedition 8
  - Proved the capability of minimally trained personnel to operate an ultrasound machine
  - Groundwork for using ultrasound as a diagnostic tool in space

- Expedition 9
  - Ultrasound images of the shoulder showed the enhanced quality of this type of imaging

Extended Results

- Expedition 10
  - Examined the eye through a closed eyelid
  - Can signify more dangerous head trauma
- ADUM Results
  - Establish ultrasound as an important device for diagnosis (i.e. on future vehicles, the Moon, Mars)

Future Application

- Success of ADUM
  - May lead to the use of ultrasound for patients in isolated areas, natural disaster sites, and the military
- With guidance from an expert (potentially hundreds of miles away), a person with minimal training could perform an ultrasound
  - Has the potential to expand the available tools for the medical community
  - Provides the ability to triage with a massive amount of patients

Works Cited

- http://www.radiologyinfo.org/en/info.cfm?pg=genus
- http://www.shuttlepresskit.com/images/iss/iss_top.jpg
- http://www.nasa.gov/mission_pages/station/research/experiments/ADUM.html
- http://www.usedultrasound.com/wp-content/uploads/2010/05/Philips-HD7-ultrasound-machine.png
- http://www.fchhh.com/uploads/files/54/med/earth-boy-for-webhorizontal.jpg
- http://microgravity.grc.nasa.gov/MSD/MSD_gifs/menu_gifs/page_menus/tsc_menus/tscwideshot.jpg