NHHPC Overview and NASA Mobile Health for Exploration Medical Capability

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NHHPC Workshop

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Member Organizations

Past and Current NHHPC Projects

- Completed projects
  - DeVenCI workshop June/Sept 2011
    - ✓ Found 3 new technologies for ISS to test
  - Rice Business School earth/space prizes
    - ✓ 2010 LyoGo – store medications for reconstitution without refrigeration
    - ✓ Diagenetix 2011 – DNA test for bacterial pathogens
    - ✓ Innovostics 2012 – microfluidic platform using whole blood for detection of infection

Past and Current NHHPC Projects

- Completed projects
  - STELLAR with Tufts – education modules to teach life science using engineering principles
  - US Navy evaluation of ISS air quality monitor
  - FAA Center of Excellence for Commercial Space Flight
- Underway
  - FAA Center of Excellence
  - UTMB training course on open innovation
  - Procter & Gamble project posting on the NHHPC website with a technical need
- Two corporate and two government projects in discussion

Health Week and Health Data Initiative

- Two-day event at the Washington Convention Center
  - Idea developed by Todd Park US CTO in 2010
  - Now 1600 participants
  - Idea is to utilize latent data, on distributed platforms, for entrepreneurs to develop applications
  - Many platform (and mHealth based) apps were demonstrated – good lead in to today
- EPA and NIH announced MyAir/MyHealth competition
  - Wearable sensor for air quality and physiologic data; $100K prize

Research and Development

- *Mission architecture* limits the amount of equipment and procedures that will be available to treat medical problems. *Resource allocation* and technology development must be performed to ensure that the limited mass, volume, power, and crew training time are efficiently utilized to provide the broadest possible treatment capability.

- NASA is looking for and developing innovative technologies for the challenges of exploration
  - Some of these technologies may have earth/space benefits

Medical Care for Exploration Missions

- Exploration missions require long-term development of compact, remote, and integrated technology solutions to address risk on exploration design reference missions (DRMs)

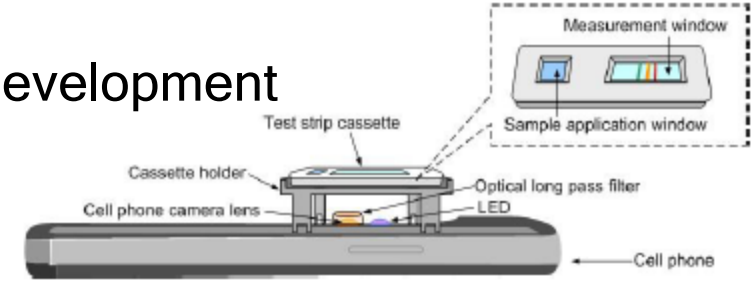
- Delivering health care via mobile devices and the mHealth trade space offers significant potential to future space operations
  - Platform independent solutions
  - Health system interoperability
  - Multiple applications (space flight and health and environmental monitoring on earth)

Mobile Lab Analysis

- NASA needs a minimally invasive, in-flight laboratory capability that minimizes consumables required for diagnosing conditions
- Current handheld rapid, laboratory analysis devices limited by temperature ranges, and maintenance of disposable cartridges
- The NASA has invested in the development of innovative mHealth platforms for laboratory analysis using smartphones.
  - Small Business Innovation Research (SBIR)
    - ✓ 3 phases of funding
    - ✓ Stepwise development
    - ✓ Multiple spheres of seed funding

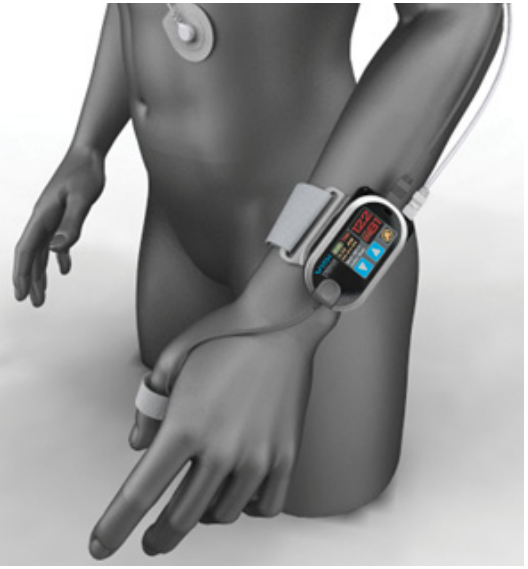
Smartphone Laboratory Analysis

- Currently two phase I SBIR grants for development



- NASA-funded smartphone laboratory analysis has focused on
  - Leveraging smartphone camera optics and florescence for analysis
  - Microfluidics, pumps, capillary action to control flow over camera
  - Computing and user interface to analyze results
    - ✓ Cloud computing models and smartphone native processing
- Ground-based health applications for remote and underserved areas where mobile phones are widespread and can be leveraged to monitor or diagnosis disease and interface with physicians (e.g. blood glucose, HIV, malaria analysis)

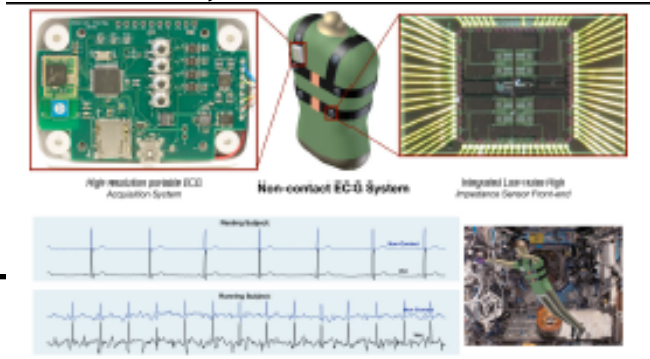
Monitoring and Data Management



- Availability of information will enable crew and mission support personnel to optimize delivery of medical care while on an exploration mission
  - Tracking of medications and consumables
  - Continuous biomedical monitoring in-flight
  - Integration of ground-based support with data management
  - Automated integration of medical peripheral data with EMR for access in-flight and on the ground
- The integrated medical model (IMM) can use continually updated resources to predict risk, ability to treat diseases, and alter approach to treatment

Monitoring and Data Management

- Mobile computing enhances functionality
  - Wireless transmission and processing of vital signs, video, medical records, and physiologic indices
  - Immediately accessible and portable
- Example: wearable ECG monitoring with mobile processing and relay
  - Dry electrode technologies
  - Following new technologies with potential ease for integration
- Applications to monitoring in emergency rooms, cross-platform integration, electronic health records, remote medicine and preventive care



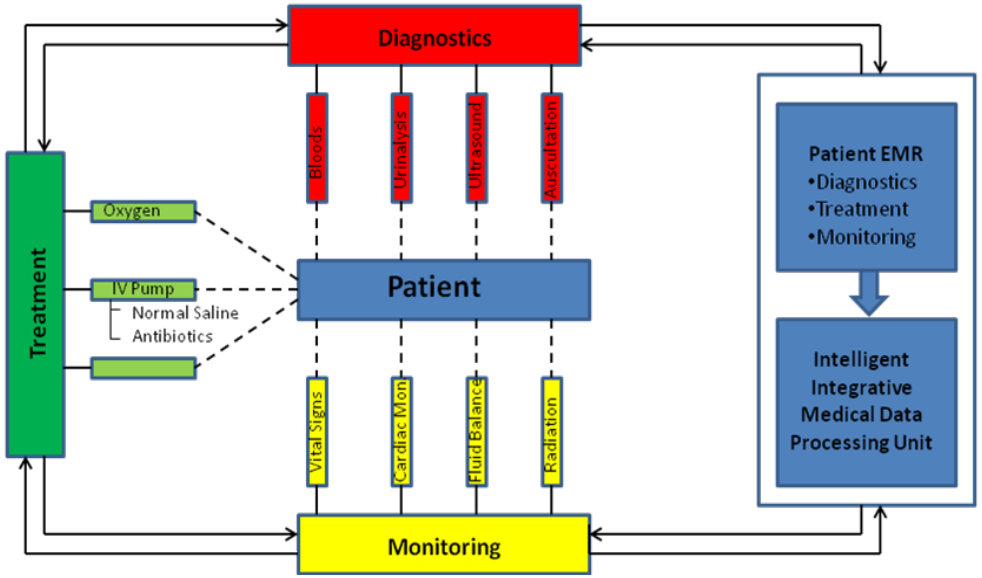
Exploration Medical System Demonstration (EMSD)

In-flight Segment

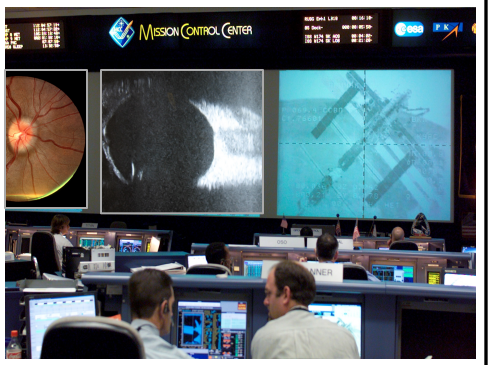
Ground Segment

Crew

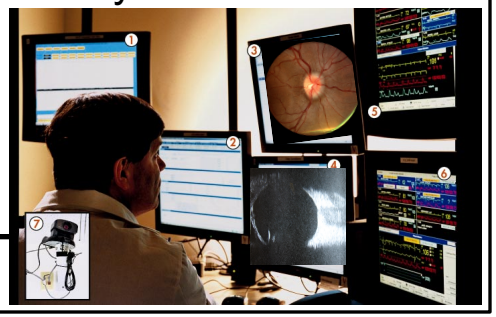
Medical Data System



Medical Mission Control



Tertiary Care Consultants



Assisted Medical Procedures

- Augmentation of initial on-board clinical decision-making
  - With communication delay and blackout periods, remote clinical decision support is important for emergent conditions and beneficial for most conditions.
  - Mobile platform currently used for decision support software because of accessibility and ease of use
- Screening and diagnosis of in-flight conditions

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- Remotely enabled and guided medical procedures are being developed and simulated
  - Can update real-time to adapt for changing resources and medical conditions
- Just-in-time assistance and personalized algorithms are possible

Multiple tabs to the organ or area

DATA COLLECTION

Set Up | Reference | Survey | Target Images | Pathology

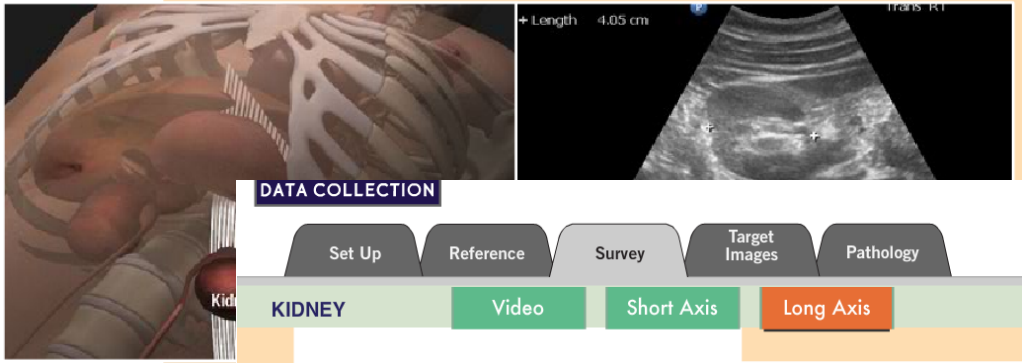
KIDNEY | Video | Short Axis | Long Axis

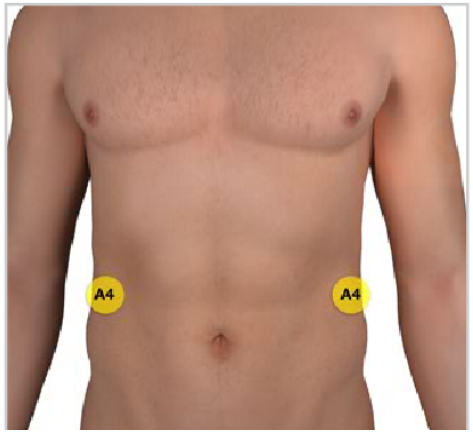
Short Axis

Place the probe at A4 with the marker towards the patient's head.

Rotate the transducer 90° clockwise for the right kidney, or 90°counter clockwise for the left kidney.

Tilt the transducer up and down to obtain the image.





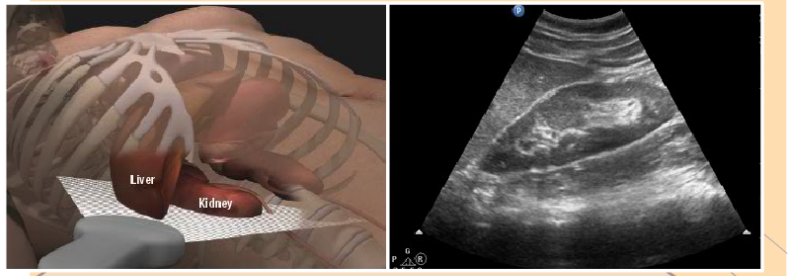
DATA COLLECTION

Set Up | Reference | Survey | Target Images | Pathology

KIDNEY | Video | Short Axis | Long Axis

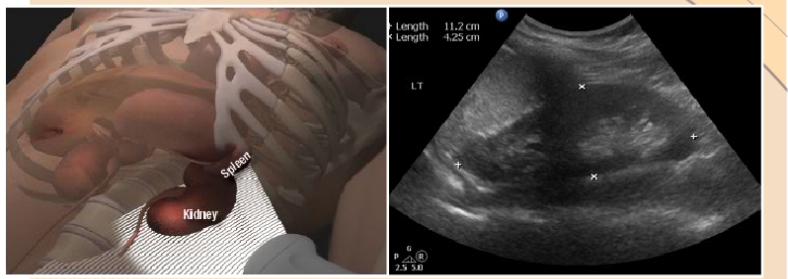
Long Axis - Right

Place the probe at A4 with the marker towards the patient's head. Adjust the probe according to the kidney's long axis. Turn the probe counter clockwise towards the patient's back.



Long Axis - Left

Place the probe at A4 with the marker towards the patient's head. Adjust the probe according to the kidney's long axis. Turn the probe clockwise towards the patient's back. More difficult to obtain images can be compared to the right kidney.



Guide through the ultrasound scan

DATA COLLECTION

Set Up | Reference | Survey | Target Images

FIBULA

The probe position and placement will depend largely on the area of injury or pain. Sensible locations for the examination will include areas of swelling or redness. This can dictate an area of bone or soft tissue damage.

Ultrasound gel should cover the entire surface that is to be scanned.

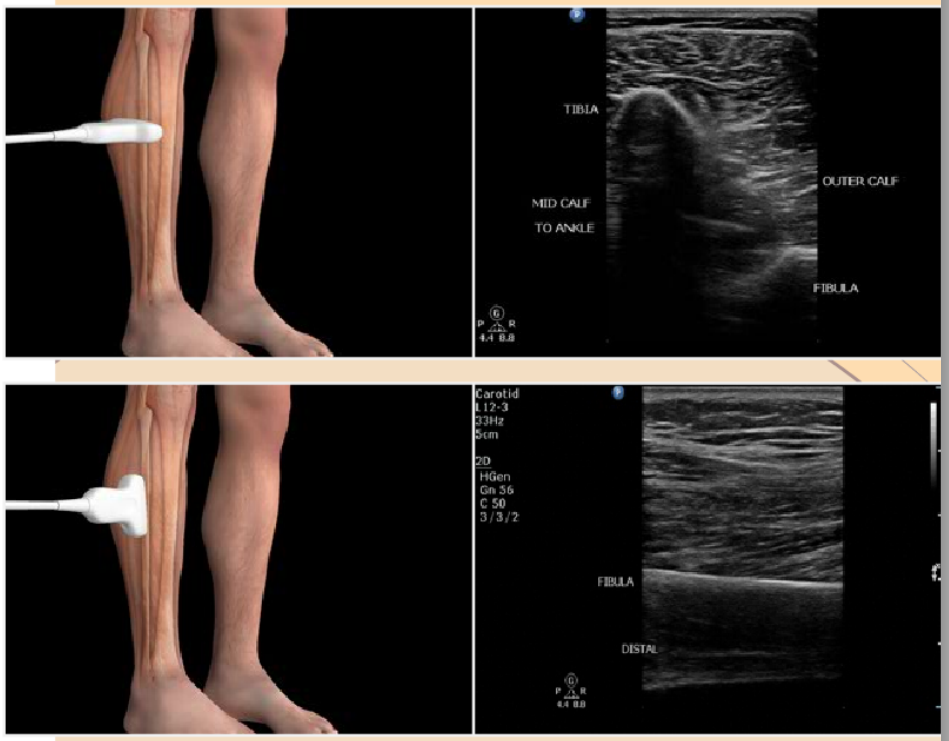
Short and Long Axis

Desired ultrasound views include the short axis of the bone with the indicator notch to the patient's right. In addition, the long axis view should be aquired along the length of the bone with the indicator notch toward the patient's head.

There are two surveys: the inner calf and outer calf.

Position #1 Leg extended and knee bent exposing the inner leg. Expose the muscle then cuff away to the two bones in the calf.

Position #2 Leg extended straight with the probe floating on the outer side near the top of the shin area. Expose the muscle then cuff away to the two bones in the calf from the other side of the calf



Telemedicine Applications for Exploration Missions

- Improved screening, diagnosis and treatment may be possible through ground-based expert assistance

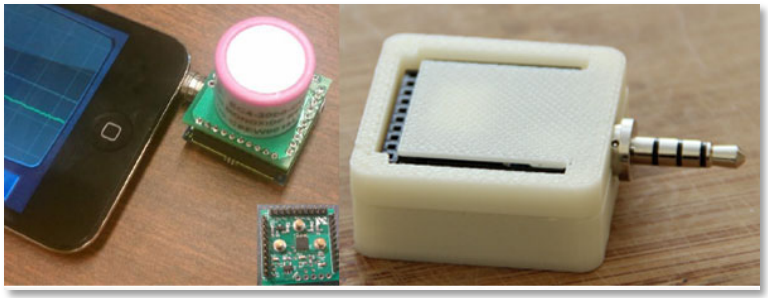
- Video interface for just-in-time training can be displayed when communication is delayed or not available
  - Tablet-targeted videos for all procedures beyond Advanced Diagnostic Ultrasound to include dental, procedural, and diagnostic tools.

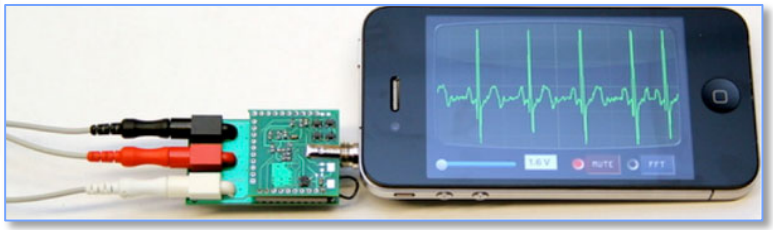
- Video transmission permits telemedicine and tele-guidance, enhanced by a mobile platform
  - Small-footprint, mobile for multiple applications, and evolving technology

- Telemedicine increasingly well-established in ground-based clinical practice from remote areas such as Antarctica, oil rigs, remote nursing in ICU

Additional Applications

- Exploration cabin atmosphere monitoring for contaminants and consumables (e.g. oxygen; carbon dioxide)
  - Geographical monitoring of environmental conditions for research, real-time monitoring, and preventive care





Terrestrial Benefits

- Interoperability of health information, medical monitoring, and environmental conditions to track, predict and prevent trends

- Shared platform for bidirectional technology flow
  - Industry development
  - Shared technology and goals

- High impact for developing and remote communities