Emergency Medical Procedures on ISS:
The User Friendly Approach

An Independent Human Factors Analysis and Review of Current Procedures, Training and Equipment

Space Human Factors Engineering (SHFE)

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- Errors in critical tasks, breakdown in crew communication and dynamics, accumulated stress from living and working in an isolated, confined and closed environment. All could jeopardize crew health and safety as well as mission objectives.

- Development of new technologies and procedures to manage trauma and acute medical problems fundamental to space operations.

- Research and technology efforts focus on: standards, protocols, and procedures for diagnosis and treatment; diagnostic to support extended medical care.

- Training in medical care will use expert systems and telemedicine procedures in light of the communication limitations.
Problem

• Emergency Medicine in Space
  – Non-expert Crew Medical Officers
  – Equipment designed for use by experts
  – Urgency and potential communications difficulties between the Flight Surgeon and Crew
  – Procedure Checklist not user-friendly
  – ISS Environment challenges (noise, lighting etc)
  – Poor Human-machine interface design and its consequences for operation of equipment on ISS has been highlighted by the ISS Expedition 1&2 Crew de-briefs.

• Part of the Solution - Human Factors analysis of
  – Procedures
  – Training
  – Equipment use by non-experts
ISS Environment

RS Service Module
location of Russian Medical Equipment

US LAB
location of CHeCS rack

Usability Testing & Analysis Facility
Habitability & Human Factors Office
Crewmember human factors challenges in the use of these procedures in an on-orbit emergency include

• Procedure entry/exit –
  – The crewmember must decide where in the Medical Checklist to initiate a procedure.
  – The Medical Checklist must provide one or two crewmembers with adequate entry and exit direction to simultaneously perform several procedures.

• Medical jargon – Checklists and procedures should attempt to provide near complete medical information using a minimum of acronyms and medical terminology.

• Attention requirement - The level of detail in the checklist must not overly focus the attention of the medical officer, pulling their attention from the victim.

These are compounded by Crew Medical Officers performing medical procedures on their fellow crewmembers, in the stressful environment of a number of situations, such as cardiopulmonary arrest.
Project Goal

- Assessment of the ISS medical checklist, procedures and equipment
  - Crew training
  - Likely emergency medical scenarios
  - Air to ground communication
  - Predicted outcomes
- Determine shortfalls (both in on-orbit and in ground support) in the procedures, training communications and equipment
- Recommend solutions that will improve survival rate of crewmembers in the event of medical emergency & prevent emergent de-orbits and potentially save the life of a crewmember
### Medical Equipment on the ISS

#### CHeCS Rack - LAB

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCPK HRM MAS &amp; Resupply Kit</td>
<td>TOCA Supply kit MAS Case SSK (2)</td>
</tr>
<tr>
<td>Audio Dos Bio Bag SSAS VOA Sample Bags TEPC Cable</td>
<td>CSA-CP Stowage Kit GSC’s FMK</td>
</tr>
<tr>
<td>CMRS LSP RSP</td>
<td>WMK HASP AMP</td>
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<tr>
<td>Defibrillator</td>
<td>VOA</td>
</tr>
<tr>
<td>Power distribution Box</td>
<td>Avionics Air Assembly</td>
</tr>
<tr>
<td>Utility Interface Panel</td>
<td></td>
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</tbody>
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#### Advanced Life Support Pack

*Usability Testing & Analysis Facility Habitability & Human Factors Office*
Crew Medical Restraint System

ISS CRMS

Patient Restraints

Main Harness w/ Shoulder Straps

CMO Restraints

Head Restraint
Defibrillator

RESPIRATORY SUPPORT PACK (RSP)
Rescue Vehicles

Soyuz

CRV- X38
Project Process

Usability Testing

- Participants – selected to have skills/training equivalent to that of Crew Medical Officer (crew members included)
- Advanced Life Support medical scenarios with detailed sequential success criterion

Phase 1

- Assess current emergency medical system by examining effects of training, procedures compliance, equipment use and communication.

Phase 2

- Proposed upgrades identified as a result of Phase I will be implemented and subsequently tested for verification of effectiveness
Methodology

Preliminary Review of Analogue Environments

- Harvard Medical School
- Baltimore Trauma Center
- Houston 911
- Analog Environments e.g. Haughton Mars Project (HMP)

Human Factors Analysis & Usability Testing at NASA JSC

- Determine patient outcome
  - Accuracy of diagnosis of patient illness
  - Time to stabilize emergency situation and patient
- Results of subject/hardware/procedures interaction (how well the crew uses the emergency medical capability provided)
- Itemize the difficulties encountered by each test participant for each scenario (categorize difficulties)
- Subjective feedback of ease of use of procedures and effectiveness of ground support communication
- Efficiency of use of procedure-driven approach to medical care
Timeline FY 2002

- Research Functional & HF requirements
- Generate Interview questions
- Data Collection
  - Set up tour or/and teleconferences to desired facilities (Baltimore, Harvard, Houston 911 incl. EMT/Paramedic, Navy Medical Corpsman training)
  - Research journals/internet
- Heuristic evaluation of current ISS Medical Procedures
- Report Findings from Evaluation
- Development of Test plan for select scenarios
- Report Findings of Data collection
- End of Year Report
BACKGROUND

MATERIAL
Deliverables

Year 1
- Report detailing finding in Phase I
- HF analysis of current NASA ISS Emergency Medical procedures/training with recommendations for improvements.
- Table with current procedures/analogues/training in remote/expedition medicine for non-medics. (how do others train or teach to response to medical emergencies?)

Year 2
- Identification & development of upgrades/improvements to requirements/procedures/training/info systems
- Initial testing of upgrade emergency medical system (continue 3rd year)
Deliverables

**Year 3**

- Analysis of data, recommendations (requirements, procedures/information & data systems, and equipment) and identification of route for on-board implementation
- Analysis to identify new systems and technology compatible with ISS infrastructure
- The identification of Commercial of-the-shelf (COTS) candidate communication/information systems, to include where possible systems already in use by NASA or approved for on-board use
- Preliminary study of potential usability testing of the new systems in analog environments
- Formal final report with recommended changes/forward work for ISS medical emergency procedures