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Performance Support Tools for Space Medical Operations

V. BYRNE[1], J. SCHMID[2], and I. BARSHI[3]
[1]Lockheed Martin, Houston, TX; [2]NASA Johnson Space Center, Houston, TX; [3]NASA Ames Research Center, Mountain View, CA

OVERVIEW

Early Constellation space missions are expected to have medical capabilities similar to those currently on board the Space Shuttle and International Space Station (ISS). Flight surgeons on the ground in Mission Control will direct the Crew Medical Officer (CMO) during medical situations. If the crew is unable to communicate with the ground, the CMO will carry out medical procedures without the aid of a flight surgeon. In these situations, use of performance support tools can reduce errors and time to perform emergency medical tasks.

The research presented here is part of the Human Factors in Training Directed Research Project of the Space Human Factors Engineering Project under the Space Human Factors and Habitability Element of the Human Research Program. This is a joint project consisting of human factors teams from the Johnson Space Center (JSC) and the Ames Research Center (ARC). Work on medical training has been conducted in collaboration with the Medical Training Group at JSC and with Wyle that provides medical training to crew members, biomedical engineers (BMEs), and flight surgeons under the Bioastronautics contract. Human factors personnel at Johnson Space Center have investigated medical performance support tools for CMOs and flight surgeons.

CMO just-in-time training and procedures tools evaluations: In Phase 1, feasibility data was gathered for two prototype display technologies: a handheld personal digital assistant (PDA) and a head-mounted display (HMD). The PDA and HMD were compared during simulation of a medical procedure using ISS-like medical equipment.. In Phase 2 we compared a wrist-mounted PDA to a paper cue card. In each phase, time to complete procedures, errors, and user satisfaction were captured.

Subject performing a procedure on a human patient simulator

Example of Mission Control ground support

Flight Surgeon Performance Support Tool conceptual development: Information needed by the flight surgeon during ISS mission support may be located in many different places around the flight surgeon's console. A performance support tool prototype is being developed to address this issue by bringing all of the relevant information together in one place. The tool could have different uses depending on the situation and the skill of the user. An experienced Flight Surgeon could use it during an emergency situation as a decision and performance support tool, whereas a new Flight Surgeon could use it as JIT training, or part of his/her regular training.

ACKNOWLEDGEMENTS

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CMO JUST-IN-TIME-TRAINING & PROCEDURE TOOLS

Aim: Investigate JIT training techniques and concepts for medical procedures.

Method:
Each phase of research was conducted with participants using a human patient simulator to perform simulated JIT medical procedures using ISS flight-like equipment.

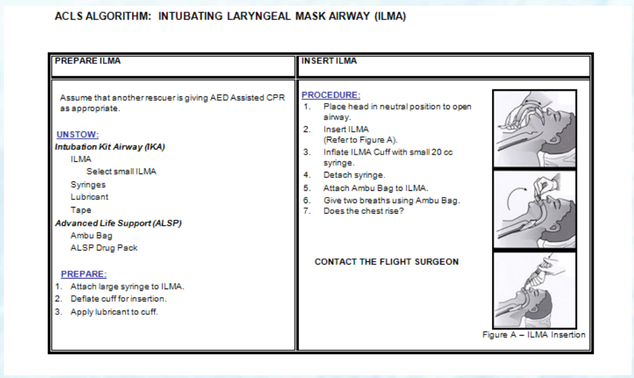
Head Mounted Display (HMD) system

Phase 1: preliminary feasibility data were gathered for two types of prototype display technologies: a handheld personal digital assistant (PDA), and a head-mounted display (HMD). Based on the outcome of Phase 1, including data on user preferences, further testing was completed using the PDA technology only.

Phase 2 explored two presentation of procedures on a wrist-mounted PDA, and compared it to a paper cue card. Time-to-complete procedures, errors, and user satisfaction ratings were captured. Three different procedures presentations were evaluated:

1) Paper cue card (8.5” x 11”)
2) PDA – Full procedure
3) Auditory presentation of procedure steps + Graphics Only

Phase 2 Evaluation Participants and Experimental design:
Nine participants with prior space medical equipment and procedures experience (Within-subjects design).



ACLS ALGORITHM: INTUBATING LARYNGEAL MASK AIRWAY (ILMA)

PREPARE ILMA	INSERT ILMA
Assume that another rescuer is giving AED Assisted CPR as appropriate. UNSTOW: *Intubation Kit Airway (IKA)* ILMA Select small ILMA Syringes Lubricant Tape *Advanced Life Support (ALSP)* Ambu Bag ALSP Drug Pack PREPARE: 1. Attach large syringe to ILMA. 2. Deflate cuff for insertion. 3. Apply lubricant to cuff.	PROCEDURE: 1. Place head in neutral position to open airway. 2. Insert ILMA (Refer to Figure A). 3. Inflate ILMA Cuff with small 20 cc syringe. 4. Detach syringe. 5. Attach Ambu Bag to ILMA. 6. Give two breaths using Ambu Bag. 7. Does the chest rise? CONTACT THE FLIGHT SURGEON

Figure A – ILMA Insertion

Procedure for a paper cue card and PDA - Full procedure conditions

Procedure displayed on wrist mounted PDA

Figure A - ILMA Insertion

Graphics Figure used in Auditory presentation condition

Phase 2 Objectives and Outcome:

1. Evaluate means of information presentation to perform real- time medical procedures.
   - Participants identified unclear areas where additional steps/information would be helpful.
   - Paper cue card provided access to the complete procedure; the PDA required some scrolling.
2. Explore the potential benefits of auditory presentation of instructions combined with graphic figures only
   - The auditory + graphics condition allowed systematic serial completion of procedures.
   - The graphics were bigger and reported to be more helpful than when presented with text.
   - The rate of the auditory presentation was identified as an issue by participants. Subjectively, it slowed down the completion of the procedure and did not allow for a “big picture” view of the entire procedure (i.e., know how far into the procedure one was).
3. Gather feasibility information about wrist-mounting a PDA to allow two-handed operation of medical procedures.
   - Seven of the nine participants reported no issues with the wrist-mounting used for the PDA conditions.
   - The exact sizing was not appropriate for all participants, but only minor adjustments were observed during the scenarios.
   - The method of securing the PDA worked very well since the unit never slipped.

Wrist mounted PDA

Paper cue card in use

FLIGHT SURGEON PERFORMANCE SUPPORT TOOL

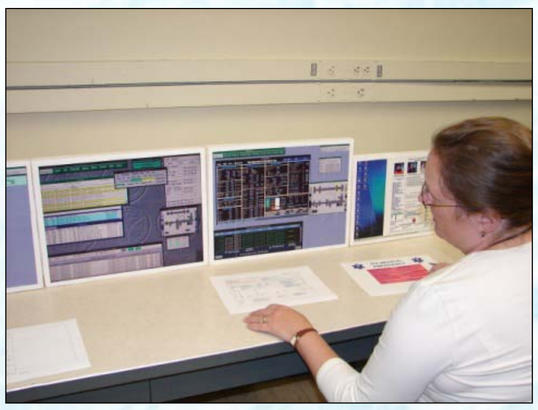
Aim: Gather feedback on flight surgeon nominal and off-nominal on-console tasks and a "Fire onboard ISS" scenario in order to further develop the flight surgeon performance support tool prototype

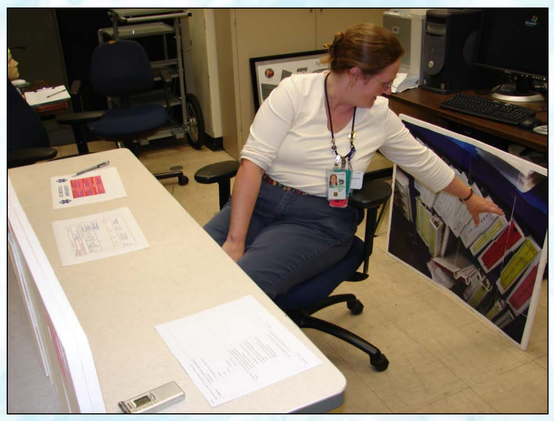
Participants:

Five certified Flight Surgeons (All had both ISS and Shuttle On-Console Experience)

Method:

For each individual interview session, a participant was asked to perform a walk-through of a 'Fire On-board ISS' emergency scenario. Flight Surgeon Console Mockup has been created to facilitate walk-thru. Topics covered included: Flight Surgeon experience; nominal beginning/ending shift activities; off-nominal fire emergencies as compared with other emergencies; The duration of each interview session was approximately one hour. The facility was set up with foam board mock-ups of the displays and hard-copy resources available in the layout of the ISS Flight Surgeon console. Interviews were audio recorded and notes were taken by the interviewer and an assistant when available.



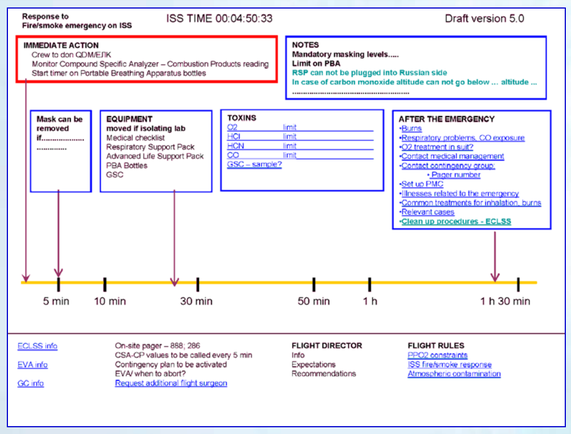


Mock-ups of displays and hard-copy resources available in the layout of the ISS flight surgeon console

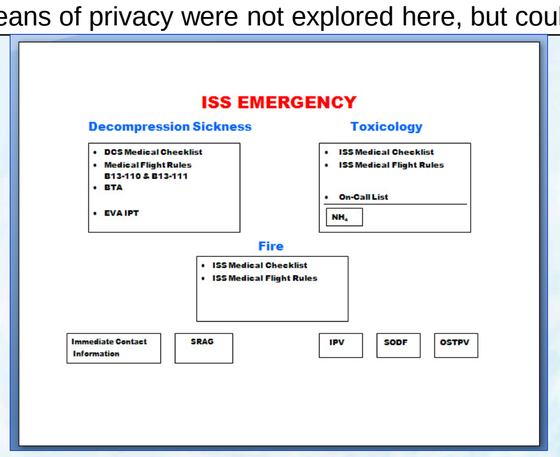
Outcome:

Common themes that emerged to aid in the performance support tool prototype development included, but not limited to recommendations on layering and organizing information based on the tasks to be performed, increasing understanding of what information is currently readily available, ensure that information is up-to-date and emphasized as a "Checklist"/Situation Awareness tool rather than a substitute for Flight Rules and procedures.

Participant Comment	**Human Factors Observation and Recommendations**
Do not look at the Surgeon Daily Tasks page or the Panic button page information. Some participants were unaware of the information and some mentioned that it was not up to date.	These current displays contain valuable information that is also covered in the Flight Surgeon Performance Support Tool prototype. Recommendations include: •Reorganize existing displays (e.g. clearly separate ISS Emergency vs. Medical Emergency) •It is important to know what information is available as a resource and this could be done in Flight Surgeon Training, during mentoring, or refresher training.
There is so much information that it could be easy to overlook pieces if focused too narrowly on the support tool. A lot of the needed current information is gathered by talking with other groups in the control room (e.g. BME and ECLSS). Recommended by participants to emphasize support tool – not a substitute for Flight Rules and Procedures.	One possible approach is to make the focus of the Performance Support Tool as a Checklist (e.g. priming questions as to who to ask for what information). Facilitate increasing level of situation awareness by listing the considerations, and pointers to what to be thinking about.
Keep resources in formats that are easy to update. It should be possible for Flight Surgeons for a specific Increment/Crew to configure the displays based on their known mission constraints.	It is noted that this might be the way to keep current information available. But some information may always be needed, and if so, it should stay in the same location on the screen to reduce scanning time.
There are different levels of information needed for the paper version and electronic versions of the Flight Surgeon Performance Support Tool. Generate a simple prototype if used as a paper reference if the Flight Surgeon will immediately be driving in to Mission Control for an emergency (Recommend Contacts, Set up PMC?, List of Flight Rules to ask for)	Next step will be to generate a streamlined version of the current paper prototype to reduce the amount of information and update the prototype to enhance the electronic design.
Privacy of medical data is a concern, some of the console set-up and display designs call attention to the data.	Display designs should make things legible for Flight Surgeons, but not legible from a distance. Other means of privacy were not explored here, but could be investigated further.



Flight Surgeon Performance Support Tool Prototype



A computer display concept drafted by a Flight Surgeon participant