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(Panel Overview Abstract)

SPACE STATION FREEDOM: EVOLUTION OF MEDICAL CAPABILITIES. R.D. Billica, M.D.*, and C.W. Lloyd, Pharm.D.

PANEL OVERVIEW: In the past year the Space Station Freedom program has advanced through a major restructuring effort and passed significant design milestones. The efforts to baseline medical functions have kept pace using a phased approach to providing new technologies and capabilities. This panel presents the results of recent efforts to solidify health care planning and provisions for the Space Station. Included are reports from clinical studies performed on Space Shuttle, KC-135 zero-gravity, and ground-based laboratories.

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Medical Care Capabilities for Space Station Freedom: A Phased Approach, C. R. Doarn and C. W. Lloyd, NASA and KRUG Life Sciences, Medical Operations Branch, Johnson Space Center, Houston, TX

As a result of Congressional mandate Space Station Freedom (SSF) was restructured. This restructuring activity has affected the capabilities for providing medical care on board the station. This presentation addresses the health care facility to be built and used on the orbiting space station. This unit, named the Health Maintenance Facility (HMF), is based on and modeled after remote, terrestrial medical facilities. It will provide a phased approach to health care for the crews of SSF. Beginning with a stabilization and transport phase, HMF will expand to provide the most advanced state of the art therapeutic and diagnostic capabilities. This presentation details the capabilities of such a phased HMF. As Freedom takes form over the next decade there will be ever-increasing engineering and scientific developmental activities. The HMF will evolve with this process until it eventually reaches a mature, complete, stand-alone health care facility that provides a foundation to support interplanetary travel. As man's experience in space continues to grow so will the ability to provide advanced health care for Earth-orbital and exploratory missions as well.

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A PROTOTYPE CREW MEDICAL RESTRAINT SYSTEM (CMRS) FOR SPACE STATION FREEDOM. S.L. Johnston*, F.T. Eichstadt, and R.D. Billica*. KRUG Life Sciences and Medical Operations, NASA Johnson Space Center, Houston, Texas.

The CMRS is a prototype system designed and developed for use as a universally deployable medical restraint/workstation on Space Station Freedom (SSF), the Shuttle Transportation System (STS), and the Assured Crew Rescue Vehicle (ACRV) for support of an ill or injured crewmember requiring stabilization and transportation to earth. The CMRS will support all medical capabilities of the Health Maintenance Facility (HMF) by providing a restraint/interface system for all equipment (Advanced Life Support packs, defibrillator, ventilator, portable oxygen supply, IV pump, transport monitor, transport aspirator, and intravenous fluids delivery systems), and personnel (patient and crew medical officers). It must be functional within the STS, ACRV, and all SSF habitable volumes. The CMRS will allow for medical capabilities within CPR, ACLS, and ATLS standards of care. This must all be accomplished for a worst case transport time scenario of 24 hours from SSF to a definitive medical care facility on earth.

A presentation of the above design prototype with its subsequent one year SSF/HMF and STS/ACRV high fidelity mock-up ground based simulations testing will be given. Also, parabolic flight and underwater Weightless Environmental Test Facility evaluations will be demonstrated for various medical contingencies. The final design configuration to date will be discussed with future space program impact considerations.

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DELIVERY OF CARDIOPULMONARY RESUSCITATION IN THE MICRO-GRAVITY ENVIRONMENT. M. R. Barratt* and R. D. Billica*. KRUG Life Sciences and Medical Operations, NASA Johnson Space Center, Houston, TX

INTRODUCTION. The microgravity environment presents several challenges for delivering effective cardiopulmonary resuscitation (CPR). Chest compressions must be driven by muscular force rather than by the weight of the rescuer's upper torso. Airway stabilization is influenced by the neutral body posture. Rescuers will consist of crewmembers of varying sizes and degrees of physical deconditioning from space-flight. Several methods of CPR designed to accommodate these factors were tested in the one g environment, in parabolic flight, and on a recent shuttle flight. METHODS. Utilizing study participants of varying sizes, different techniques of CPR delivery were evaluated using a recording CPR manikin to assess adequacy of compressive force and frequency. Under conditions of parabolic flight, methods tested included conventional positioning of rescuer and victim, free-floating "Heimlich-type" compressions, straddling the patient with active and passive restraints, and utilizing a mechanical cardiac compression assist device (CCAD). Multiple restraint systems and ventilation methods were also assessed. RESULTS. Delivery of effective CPR was possible in all configurations tested. Reliance on muscular force alone was quickly fatiguing to the rescuer. Effectiveness of CPR was dependent on technique, adequate restraint of the rescuer and patient, and rescuer size and preference. Free-floating CPR was adequate but rapidly fatiguing. The CCAD was able to provide adequate compressive force, but positioning was problematic. CONCLUSIONS. Delivery of effective CPR in microgravity will be dependent on adequate rescuer and patient restraint, technique, and rescuer size and preference. Free-floating CPR may be employed as a stop-gap method until patient restraint is available. Development of an adequate CCAD would be desirable to compensate for the effects of deconditioning.

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ADVANCED CARDIAC LIFE SUPPORT (ACLS) UTILIZING MAN-TENDED CAPABILITY (MTC) HARDWARE ONBOARD SPACE STATION FREEDOM. M. Smith, M. Barratt, C. Lloyd. NASA and KRUG Life Sciences, Inc. Medical Operations Branch, Johnson Space Center, Houston, Texas 77058.

INTRODUCTION. Because the time and distance involved returning a patient from space to a definitive medical care facility, the capability for Advanced Cardiac Life Support (ACLS) exists onboard Space Station Freedom. METHODS. In order to evaluate the effectiveness of terrestrial ACLS protocols in microgravity, a medical team conducted simulations during parabolic flight onboard the KC-135 aircraft. The hardware planned for use during the MTC phase of the space station was utilized to increase the fidelity of the scenario and to evaluate the prototype equipment. Based on initial KC-135 testing of CPR and ACLS, changes were made to the ventricular fibrillation algorithm in order to accommodate the space environment. Other constraints to delivery of ACLS onboard the space station include crew size, minimal training, crew deconditioning, and limited supplies and equipment. RESULTS. The delivery of ACLS in microgravity is hindered by the environment, but should be adequate. Factors specific to microgravity were identified for inclusion in the protocol including immediate restraint of the patient and early intubation to insure airway. External cardiac compressions of adequate force and frequency were administered using various methods. The more significant limiting factors appear to be crew training, crew size, and limited supplies. CONCLUSIONS. Although ACLS is possible in the microgravity environment, future evaluations are necessary to further refine the protocols. Proper patient and medical officer restraint is crucial prior to advanced procedures. Also, emphasis should be placed on early intubation for airway management and drug administration. Preliminary results and further testing will be utilized in the design of medical hardware, determination of crew training, and medical operations for space station and beyond.

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A SURGICAL SUPPORT SYSTEM FOR SPACE STATION FREEDOM. M. R. Campbell*, R. D. Billica*, and S. L. Johnston*. KRUG Life Sciences and Medical Operations, NASA Johnson Space Center, Houston, Texas.

INTRODUCTION. Surgical techniques in microgravity are being developed for the Health Maintenance Facility (HMF) on Space Station Freedom (SSF). This will be a presentation of the proposed surgical capabilities and ongoing hardware and procedural investigations. METHODS. Procedures and prototype hardware, which include a medical restraint system, a surgical overhead isolation canopy, a suction device, and a regional laminar flow device were evaluated. This was accomplished by realistic sterile surgical simulations involving both mannequins and animals during KC-135 parabolic flight and in a high fidelity ground based HMF mockup. RESULTS. Animal surgery in the environment of microgravity allowed the observation of unique arterial and venous bleeding characteristics for the first time. The ability to control bleeding and to prevent cabin atmosphere contamination was also demonstrated. CONCLUSIONS. The procedures and prototype hardware tested provided valuable information and should be investigated and developed further. The use of standard surgical techniques are possible in microgravity if the principles of personnel and supply restraint and operative field containment are adhered to.