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APPLICATION AND USE OF SPINAL IMMOBILIZATION DEVICES
IN ZERO-GRAVITY FLIGHT

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GOAL:

To assess the adaptability of off-the-shelf spinal immobilization equipment for use during microgravity and the evaluation of the application procedures of the equipment.

OVERVIEW:

A KC-135 parabolic flight was performed on Tuesday, February 27, 1990 for the purpose of evaluation of spinal immobilization techniques in microgravity. The flight followed the standard 40 parabola profile with four NASA/KRUG experimenters involved in the effort. One performed as coordinator/recorder, one as test subject, and two as the Crew Medical Officers (CMO). The flight was to evaluate the application of spinal immobilization devices and techniques in microgravity as are performed during initial stabilization or patient transport scenarios. The sequence of detail for examination of the following listed objectives included: attempted cervical spine immobilization with all free-floating, the patient restrained to the floor, various hand positioning techniques; c-collar placement; Kendrick Extrication Device (KED) application with various restraints for patient and CMO; patient immobilization and transport using the KED; patient transported on KED and spine board. Observations for each task are included with this report. Description of inflight photography is included. Major conclusions and issues include: 1) CMO restraint must precede patient restraint in order to properly stabilize the cervical spine; 2) terrestrial protocols for application of cervical spine immobilization must be adapted for use in microgravity; 3) current equipment used for spinal immobilization appears to be easily used as "off the shelf" or with minor modifications; 4)

movement of the patient for transport after immobilization was accomplished easily.

OBJECTIVES:

1. Determination of the proper technique required to apply cervical spine immobilization in microgravity by hand placement.
2. Evaluation of off-the-shelf equipment for spinal immobilization: hard cervical collar, and the kendrick extrication device.
3. To determine the proper technique for application of the equipment in microgravity while maintaining cervical spine precautions.
4. To assess the proper position of the Crew Medical Officers and assistants for application and stabilization procedures.
5. To subjectively assess the ease with which the apparatus may be applied in comparison with the 1-G environment.
6. To evaluate the time required to apply stabilization and equipment in microgravity.
7. To evaluate the comfort of the equipment for the patient.
8. To evaluate the ability to transport the patient in a microgravity environment while immobilized with the equipment.

BACKGROUND:

Cervical spine immobilization and stabilization is one of the basic principles behind the application of basic trauma life support and a basis for the continued application of advanced measures. It is required that to provide these essential services to the trauma patient, appropriate measures are followed from the first moment care is begun. On the space station, the Health Maintenance Facility (HMF) is designed to accommodate the care of one critically ill or injured crewmember from injury through stabilization and transport to the ground. The possibility for cervical spine injury exists at any place where humans are performing work and utilizing machinery or equipment. In planning for the provision of trauma life support, it is

necessary that the specific steps in the provision of the care be accurately evaluated for any required adaptations to the unique environment of space. This includes the equipment and the procedures for utilization.

REQUIREMENTS:

Materials:

1. Hard collar for cervical spine stabilization
2. KED
3. Long spinal board
4. Restraints for caregivers and recorder
5. Photography
6. Clipboard and writing materials
7. Tape

PERSONNEL AND SUPPORT:

- Two operators, one subject, and director/recorder
- Video recording by director and non-dedicated still photography by NASA.

PRE-FLIGHT PROCEDURES:

1-G Testing of ATLS Protocols

1. Ground based training in the Parsec II lab to identify the procedure required for application of spinal immobilization equipment.
2. Identify victim as having the potential for a spinal cord injury.
3. Move patient to work area while protecting the spine.
4. Stabilize the cervical spine and apply collar.
5. Identify appropriate spinal immobilization device to be used (i.e. K.E.D. vs long board).

6. Prepare the board for use.
7. Restrain the patient while the device is being applied.
8. Place patient on the board while protecting the spine.
9. Restrain patient on the board.
10. Move patient while on restraint to the work area.
11. Document good technique was used during the procedure.

INFLIGHT PROCEDURES

Parabolas 1 - 10

These parabolas will be used to evaluate the safest method of moving an injured crewmember to the work area while maintaining cervical spine precautions. After the patient has been moved, a hard neck immobilization collar will be applied.

Cervical Spine Stabilization With Collar

1. The patient is found floating and has suspected cervical spine injury. The 2 CMO's will approach the patient and will assume assigned roles as leader and team member. The leader (CMO 1) will take position at the patient's head and places their hand on the patient's head and neck to stabilize it. He will explain to the patient what to expect, and not to move his head or neck. The CMO 2 will position himself over the patients upper torso to facilitate stabilization of the body.
2. The CMOs will attempt to move the patient to the work area while maintaining cervical spine stabilization while only utilizing their hands.
3. This will be first attempted with the CMOs and the patient unrestrained.
4. This will be repeated with the CMOs utilizing cords over their feet for stabilization.
5. The scenario will then be repeated with the CMO 1 stabilizing the patient's cervical spine with his hands and CMO 2 will attempt proper placement of a hard cervical collar.

6. The CMOs will then attempt to move the patient while maintaining stabilization with the cervical collar in place.

Parabolas 11 - 20

These parabolas will be used to evaluate the appropriate method of applying a short spinal immobilization device known as the KED board. This device wraps around the torso and head to prevent movement of the upper spine.

KED Application

1. CMOs float to patient who is free floating and has the cervical collar in place. CMO 1 places the KED around the patients torso and holds onto the patients head portion of the device.
2. CMO 2 then floats to the front of the patient and applies the chest pieces around the patient. He then fastens the chest straps firmly in place.
3. CMO 2 then pulls the leg straps through the patient's legs and crosses them to fasten left to right, and right to left. These are then tightened firmly.
4. CMO 2 then wraps the head portion of the device around the patient's head and affixes this portion using the head strap over the forehead.
5. The patient should then be securely immobilized from the hips to the head.
6. The CMO's will then attempt to move the patient while in zero gravity to the work area, guiding movement with the device.
7. This will be reattempted with the CMO's utilizing foot restraints for CMO 1 as he holds the patient.
8. If there are any parabolas left, the CMO's will alternate roles, and reattempt the application.

Parabolas 21 - 30

These parabolas will be used to evaluate the appropriate application of a long spinal immobilization board in a patient with a suspected spinal cord injury. This board is a full length wooden board placed against the patient's back and held in place with straps. It prevents movement of the entire spine.

Long Board Application

1. The patient is floating freely. The CMOs approach the patient with the long board and supplies.
2. CMO 1 takes position as leader at the patient's head, places his hands on the patient's head to stabilize it. CMO 1 places hands on each side of head with thumbs along the mandible and fingers behind the head on the occipital ridge. He maintains gentle and firm in-line stabilization until the devices are applied. The leader then briefly explains to the patient what to expect, why it is being done and not to move his head or neck.
3. CMO 1 assigns assistants to areas of the patient's body that they will be responsible for. CMO 2 is to be at the front of the patient over mid torso, and CMO 3 is to manage the long board from the opposite side.
4. CMO 1 directs that CMO 2 is to position extremities so as not to injure them with turning the patient.
5. CMO 1 then announces that as a group they will roll the patient over to the right side and CMO 3 will move the long board into position.
6. They roll the patient as a group to his side, CMO 3 places the board and they roll the patient back onto the board. CMO 1 is to keep the patient's nose in alignment with the umbilicus at all times during the move.

Cervical Collar, Bags, and Tape

1. CMO 1 continues to hold inline stabilization of the head, as CMO 2 applies the cervical collar.
2. CMO 1 releases in line stabilization and continues to place hands on patient's head to hold in alignment. CMO 3 places bags at patient's head

on both sides, and CMO 2 then tapes the patient across his forehead to the board, over the bags to prevent rotation and lateral head movements.

3. CMO 2 and 3 apply straps to patient to encircle, at shoulders, hips and knees.
4. If there are any parabolas left the CMOs 1 and 2 will alternate roles.

Parabolas 31 - 40

These parabolas will be used to reevaluate any procedures that had difficulties during the previous parabolas. If no repeat procedures are required, these parabolas will be used for evaluation of a sort spinal board. These will follow the application procedures for the KED with the addition of the section of application of the cervical collar, bags, and tape.

KC 135 INFLIGHT WORKSHEET

APPLICATION AND USE OF SPINAL IMMOBILIZATION DEVICES

MANIFEST: Debra Krupa - DK (KRUG)
John Gosbee - JG (KRUG)
Roger Billica - RB (KRUG)
Joey Boyce - JB (NASA)

PARABOLAS 1 - 10

1. Cervical spine stabilization manually and patient movement
Unrestrained
Restrained
2. Application of hard cervical collar and patient movement

PARABOLAS 11 - 20

1. KED application without restraints
2. KED application with foot restraints

PARABOLAS 21 - 30

1. Movement of patient on KED
2. Application of long board

PARABOLAS 31 - 40

1. Movement of patient on long board

Repeat previous scenarios with alternate CMO's and refine as required.

RESULTS AND DISCUSSION:

Manual Cervical Spine Stabilization:

It was very difficult to adequately stabilize or immobilize the patient with the CMOs and patient free floating. The CMO's each tended to use the patient as leverage in this situation, which then created a medically contraindicated situation. It appeared to be most successful to restrain one CMO prior to restraint or attempt to stabilize the patient. This allowed the restrained CMO(1) to establish control over the patient movements. CMO2 was then easily able to move the patient to the proper position for CMO1 to stabilize. As CMO1 held the patient stable, CMO2 was able to restrain himself and then work in coordination with CMO1 to attain spinal immobilization.

Attempts to manually immobilize the patient's head/neck with the patient in the standard one gravity (G) position (at the top of the patient's head) was not easily performed, nor did it prove to adequately immobilize the head/neck.

The preferred method identified for manual stabilization of the head/neck was for the CMO to confront the anterior aspect of the patient (face-to-face), place his forearms against the patient's chest and place his hands around the patient's jaw (as in the chin lift jaw thrust maneuver). This provided the strongest sense of stabilization to both the CMO and to the patient, and was the easiest to perform.

The maneuvering of the patient was performed with the patient in the neutral position of microgravity. This appeared to be the method appropriate

for provision of minimal risk of further spinal injury. It was identified by the experimenters that this preferred sequence of events might imply an adjustment to standard terrestrial basic life support protocols.

Application of Hard Cervical Collar:

After acquisition of appropriate stabilization and restraint, it was a fairly simple task to apply a C-collar. One CMO was used to stabilize the head/neck as described above, and one CMO applied the collar. The patient reported that the collar stabilized his head/neck to a much larger degree than manual stabilization.

Application of KED

Again it was discovered that once the patient and CMO were adequately restrained, it was fairly simple to apply the KED. The CMOs and the patient each reported that the KED provided adequate stabilization. It was noted that the easiest method for placement of the patient on the KED was to lift him and slide the KED beneath him.

Patient Movement with KED:

With the patient restrained within the KED it was very easy to transport and maneuver the patient while maintaining spinal immobilization. The first attempts at transport appeared somewhat awkward, and this was attributed to the CMO's inexperience in microgravity. The location of the hand holds on the KED made it quite easy to maneuver the patient through 360 degrees of movement directions and maintain control as well as stabilization. The patient reported that he felt very secure, and restrained within the KED through all movements.

Application of long board

The combination of the KED and a full-length back board provided very effective stabilization and additional control for transport. However, the additional length of the long board and its rigidity made it more difficult to maneuver. The buckle type straps were easier to apply and adjust than the velcro straps. The velcro straps were difficult to locate and release.

PHOTOGRAPHY

Stills:

S90-31808

The patient (JB) is free floating. JG and RB are attempting to control his movements and move him into position for stabilization.

S90-31809

JB has been moved to the floor of the aircraft for restraint. JG is attempting to stabilize his head/neck from the anterior while RB places the cervical collar on. RB and JG are restrained by bungee cords over their legs and JB has bungee cords over his chest.

S90-31810

After placing the cervical collar on JB, JG is lifting JB for RB to slide the KED into position. Note the placement of the various bungee cords for restraint. DK is filming in the background

S90-31811

RB is holding JB head stable as JG secures the chest straps of the KED.

S90-31812

Same as 318811

S90-31813

Same as 31811. RB is repositioning his restraint cords. (The floor is uncomfortable on knees after a while.)

S90-31814

Same as 31811

S90-31819

RB and DK are attempting to transport JB in the KED. Note that RB is able to brace himself between the floor and ceiling of the aircraft. It is very easy to move JB around in the KED.

S90-31820

RB and DK are turning JB to transport him down the length of the aircraft.

S90-31821

RB and DK are moving JB through the aircraft with the KED. They use the hand ropes to translate through the aircraft.

S90-31822

RB and DK are returning JB to the long spine board. He is not falling. He is floating.

S90-31823

RB and DK are preparing to secure JB to the spine board.

S90-31824

To secure JB to the spine board, RB is secured to the grid, and DK has placed her heels beneath bungee cords. RB is securing the chest strap. DK is reaching across to find the thigh strap.

S90-31825

RB and DK are lifting JB on the spine board for transport.

S90-31826

RB and DK are lowering JB back to the floor.

Video:

NASA reference - customer supplied VHS - work order # 04051.

Video was reviewed by the experimenters. Overall quality was good, with occasional sections of the film out of proper line of sight related to the inexperience of the director to filming in microgravity. Observations from the video are included within the above discussions.

CONCLUSIONS:

This flight experiment was extremely worthwhile in assisting to clarify and define the issues related to medical immobilization, stabilization, and transport. It was clear to the experimenters that terrestrial protocols may not apply universally for microgravity and that CMO restraint must precede patient restraint. The terrestrial mechanisms for spinal immobilization performed equally effective in microgravity.

It was decided that the order of events for this procedure should be:

- one attendant is well stabilized
- second attendant moves patient to first attendant
- the patient is stabilized
- the patient is then placed within the immobilization devices
- the patient is ready for transport

Face to face/neck stabilization provided optimal positioning for stabilization in microgravity. The hard collar was more effective than manual stabilization.

It was impossible to place the patient in the KED without restraints on the attendants. The attendants frequently used the patients clothing for lifting/movement of the patient. The ease of placement of immobilization devices will depend upon what type of restraint devices are available throughout the station for the attendants.

The placement of the long board was easily completed.

Lifting patient to place on various immobilization devices is preferred to rolling.

RECOMMENDATIONS:

1. The procedure identified during this flight for proper microgravity immobilization/stabilization of the cervical spine should be recorded and maintained for inclusion in further evaluations to enable proper inclusion in the operational data file.
2. Continued flights for performance of trauma life support procedures and equipment are recommended to identify any further adjustments to standard terrestrial protocols.
3. Evaluation of restraint mechanism for the CMO should continue, as this appeared to be the rate limiting step in many procedures.
4. The principles of design of the KED should be incorporated within the design of the transport portion of the patient restraint. This device provided appropriate stabilization as well as ease in transport.
5. Further flights for the evaluation of transport principles and procedures should occur to build upon this flight.