U.S. Army Aeromedical Interior Space Study

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Agenda

- Background
- Objective
- Methods
- Results
- Discussion
- Conclusions

Background

- USAARL's study in 1986 determined the minimum standards for vertical and lateral separation of litters to be 20 inches and 21 inches, respectively, while a flight medic provided enroute medical care onboard the UH-1.

- USAARL analysis of surveys to military transport care providers identified several areas of concern, including: (1) Space to render enroute care, and (2) Fatigue and back/neck pain.

- Capabilities Based Assessment (CBA) by the Medical Evacuation Enterprise identified several gaps that were directly attributed to the current Patient Handling Systems (PHS) used onboard the UH/HH-60 Medical Evacuation (MEDEVAC) aircraft.

Objectives

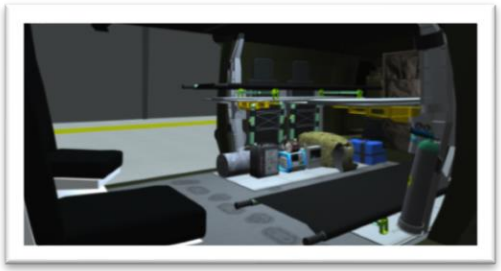
1. **(Space Study)** Evaluate the adequacy of space available for Critical Care Flight Paramedics (CCFPs) to perform advanced medical treatment scenarios on simulated critical care patients (manikins) in existing MEDEVAC aircraft.
   a. Characterize motion and posture of CCFPs
   b. Determine vertical space required for successful medical treatment

2. **(Task Saturation Study)** Conduct medical scenarios in an HH-60M interior and determine number of trauma patients to which a CCFP can successfully provide en route medical care while aboard the HH-60M.

Space Study

Methods (Space Study, Phase 1)

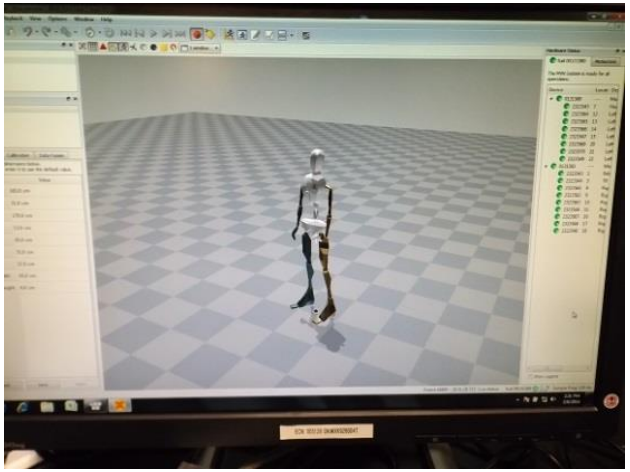
- Three configurations: Slick UH-60, UH-60 IMMSS, HH-60 BMI
- Three medics tested: 2nd percentile female, 80th percentile male, and 99th percentile male. An additional 75th percentile male medic tested as a backup to the 80th percentile male medic
- Each medic wore an Xsens motion capture suit
- Created 3D models of participating medics (i.e., avatars)
- Created 3D models of aircraft, internal configurations, and Medical Equipment Set (MES) items
- 43 medical tasks – proficiency evaluated by Medical Validator (Physician Assistant) prior to testing at the U.S. Army School of Aviation Medicine (USASAM) Dustoff Complex TA-1



Methods (Space Study, Phase 1)

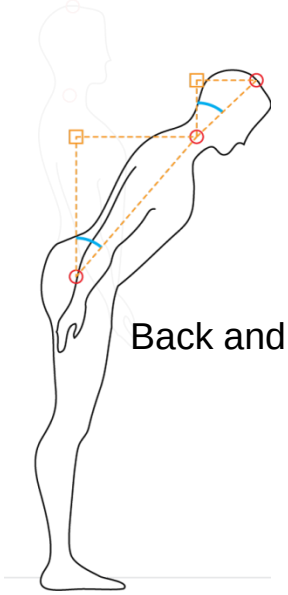
Motion data integrated with interactive 3D application

- 3 GoPro™ cameras
- Apply body motion to the avatar models
- Issue: Motion Grid is sensitive to metal
- Manually refine animation based on GoPro™ footage to limit deviation based on suit shifting and Motion Grid issue



Methods (Space Study, Phase 1)

- Measurements:
  - Recorded *x*-, *y*-, and *z*-axis dimensions from each sensor with respect to center of litter pan
  - Calculated time-weighted back and neck angles for each task and scenario



Back and Neck Angles

Coordinate System

Methods (Space Study, Phase 1)

Medical Tasks

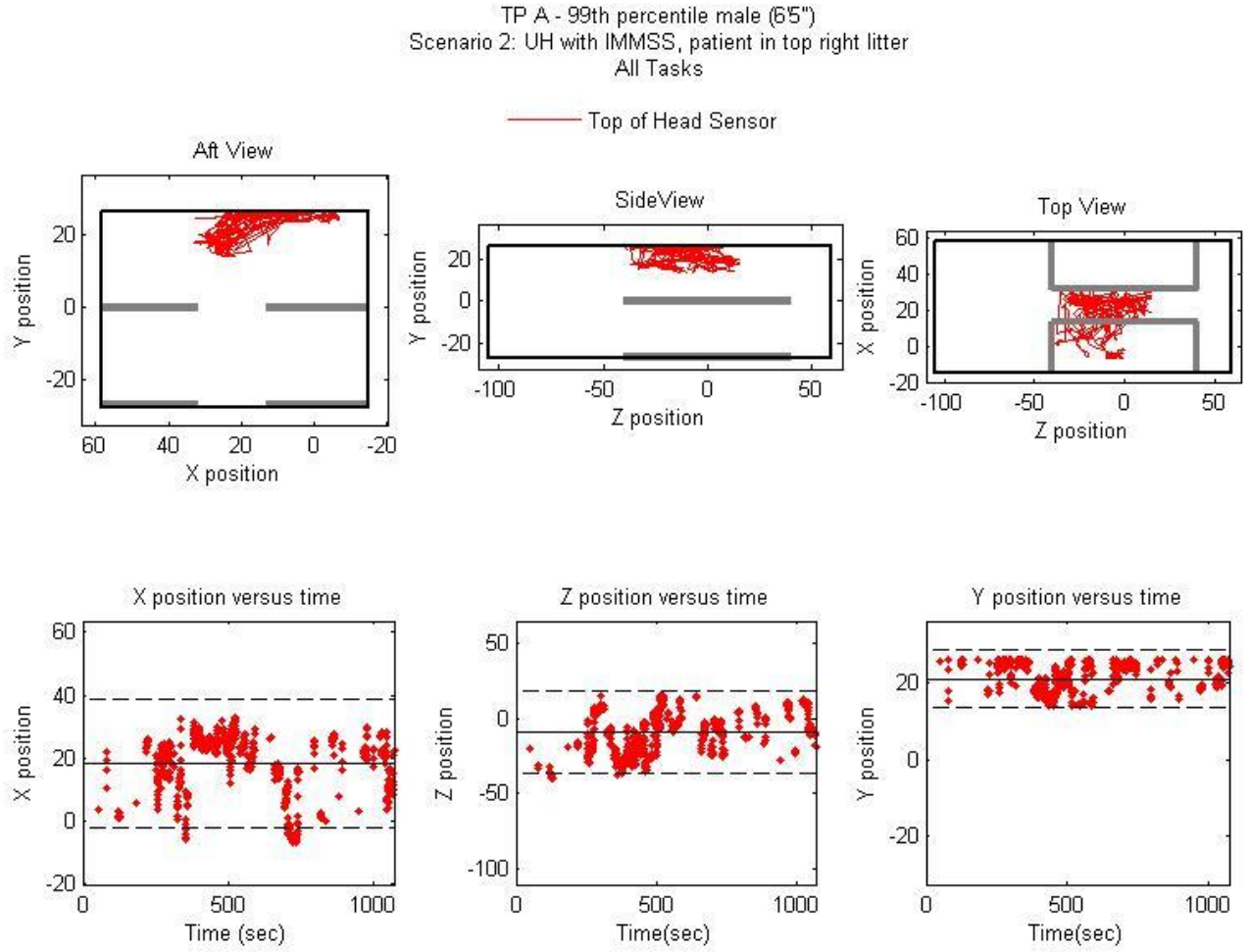
Task 1: Load casualties into helicopter
Task 2: Open the airway
Task 3: Insert an oropharyngeal airway
Task 4: Insert a nasopharyngeal airway
Task 5: Insert a King LT
Task 6: Intubate a patient
Task 7: Perform a surgical cricothyroidotomy
Task 8: Perform endotracheal suctioning of a patient
Task 9: Perform oral and nasopharyngeal suction of a patient
Task 10: Treat a casualty with a chest injury
Task 11: Insert a chest tube
Task 12: Administer initial treatment for burns
Task 13: Perform rescue breathing
Task 14: Ventilate a patient with bag-valve-mask system
Task 15: Set up a D-sized oxygen tank
Task 16: Perform esophageal suction of a patient
Task 17: Administer oxygen
Task 18: Measure a patient's pulse oxygen saturation
Task 19: Measure a patient's blood pressure
Task 20: Operate the Propaq
Task 21: Operate the Zoll
Task 22: Operate the Alaris IV pump
Task 23: Operate the IV fluid warmer
Task 24: Use the SMEED for patient movement items
Task 25: Measure a patient's pulse
Task 26: Measure a patient's temperature
Task 27: Perform advanced cardiac life support (CPR)
Task 28: Initiate treatment for hypovolemic shock
Task 29: Initiate an intravenous infusion
Task 30: Initiate a FAST 1
Task 31: Establish intraosseous infusion
Task 32: Apply a pressure dressing to an open wound
Task 33: Apply a hemostatic dressing
Task 34: Provide basic emergency care for an amputation
Task 35: Apply a tourniquet to control bleeding
Task 36: Treat a casualty with an open abdominal wound
Task 37: Treat a casualty with an impalement
Task 38: Treat a casualty with an open or closed head injury
Task 39: Apply a cervical collar
Task 40: Immobilize the pelvis
Task 41: Immobilize a suspected fracture of the arm or dislocated shoulder
Task 42: Apply a traction splint
Task 43: Apply a REEL splint

Phase 1: Test Participant (TP) Anthropometric Measurements and Percentiles

Item	TP A	TP B	TP C1	TP C2
Gender	Male	Female	Male	Male
Percentile based on height*	**>99th**	**2nd**	**80th**	**75th**
Height (centimeter [cm])	196.0	150.0	181.0	180.0
Foot (cm)	29.5	22.5	32.0	29.0
Arm span (cm)	204.0	150.0	182.0	173.0
Ankle height (cm)	11.0	8.3	7.0	8.0
Hip height (cm)	104.5	77.5	99.0	90.0
Hip width (cm)	25.0	20.0	23.0	25.0
Knee height (cm)	58.0	44.0	53.0	49.0
Shoulder width (cm)	40.5	30.5	38.0	42.0
Sole thickness (cm)	2.0	2.0	4.0	2.0
Weight (kilogram [kg])	99.8	61.2	77.6	90.7

*Gordon et al. (1989)

Results (Space Study, Phase 1)



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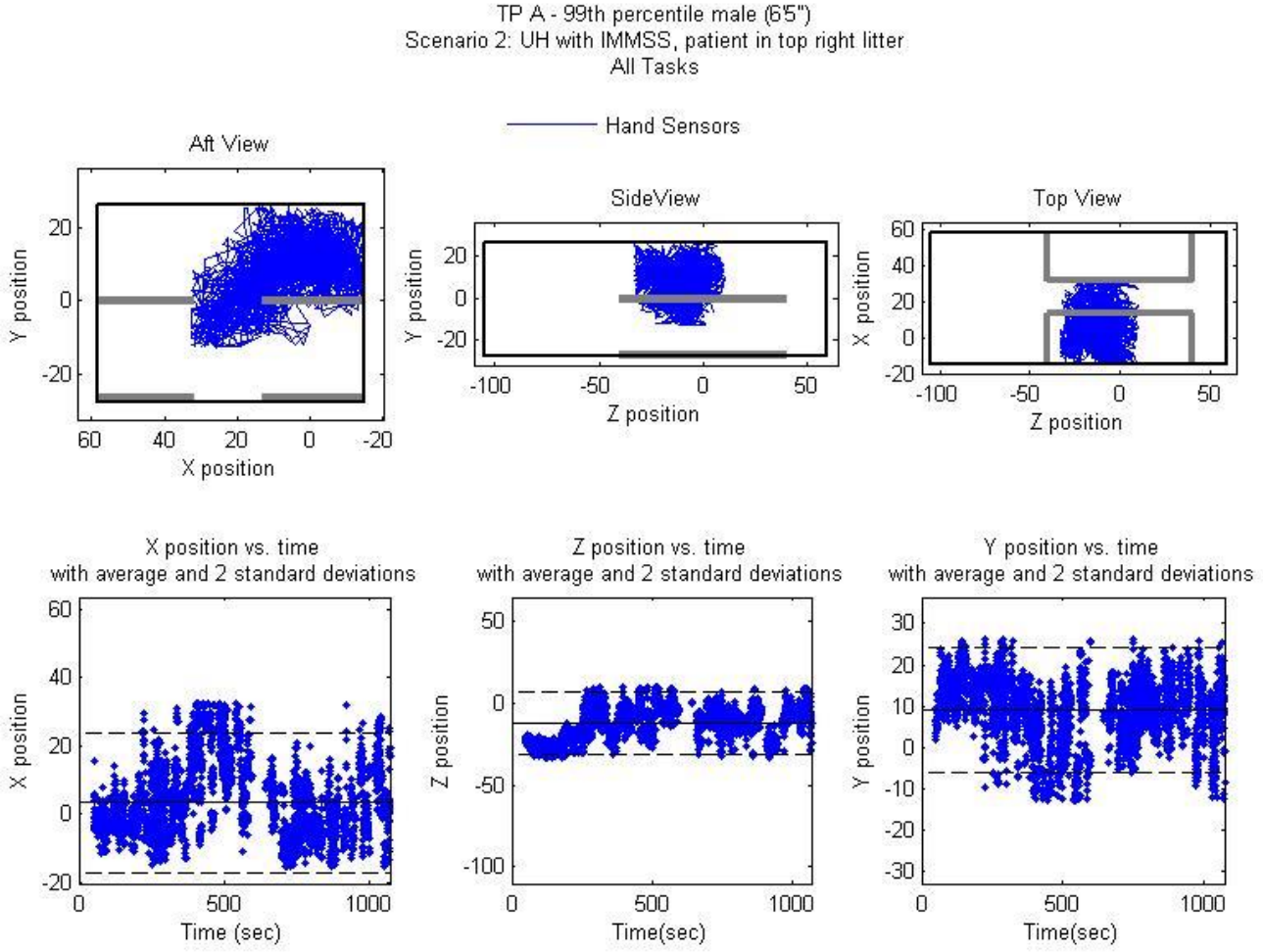

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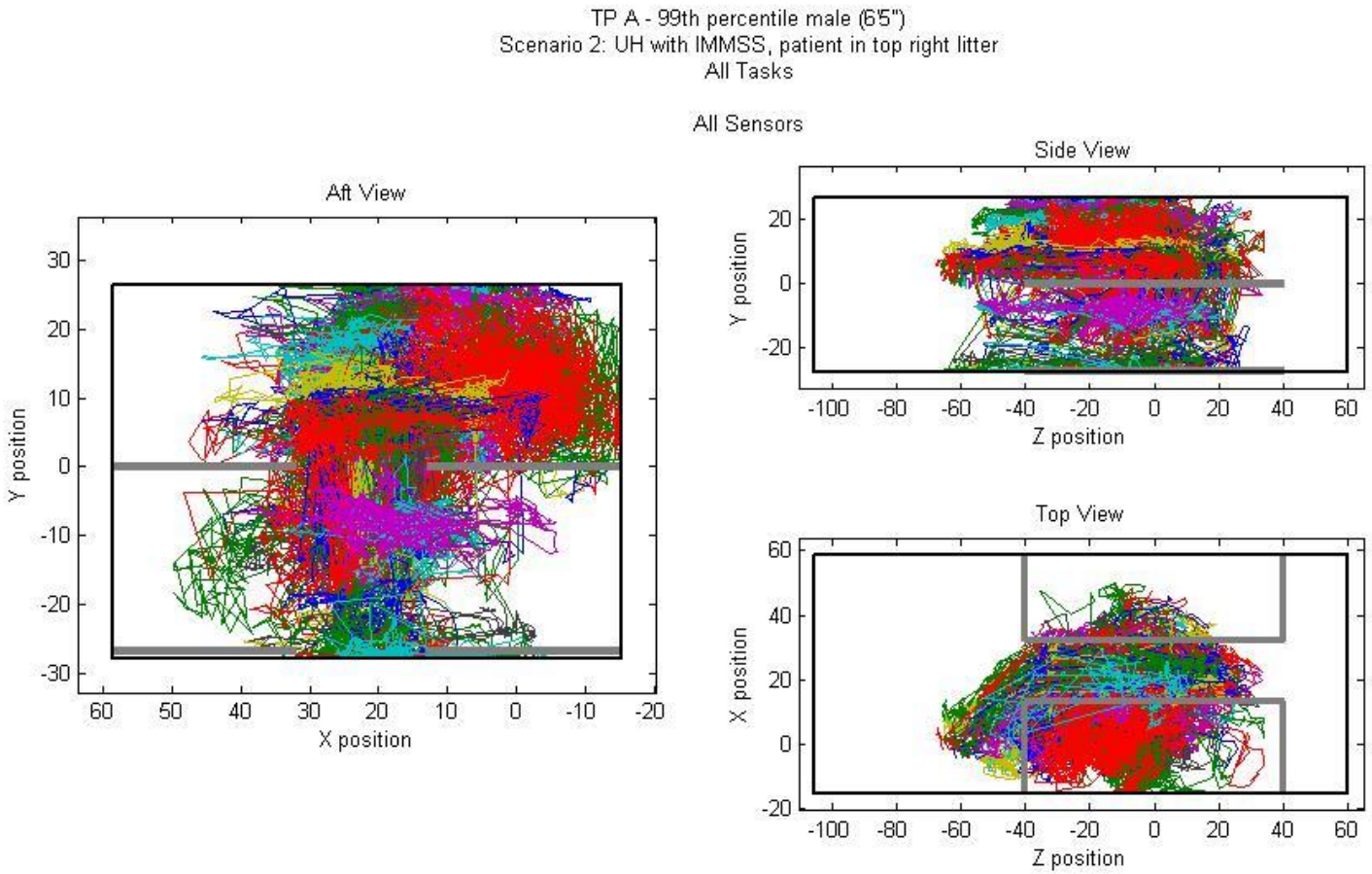
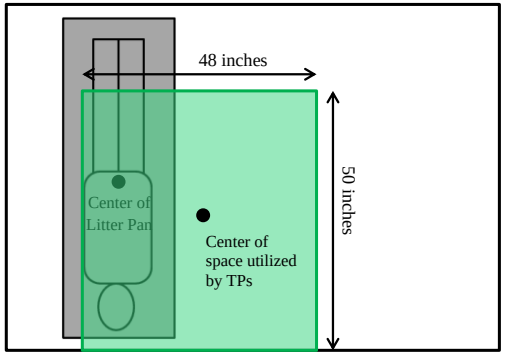
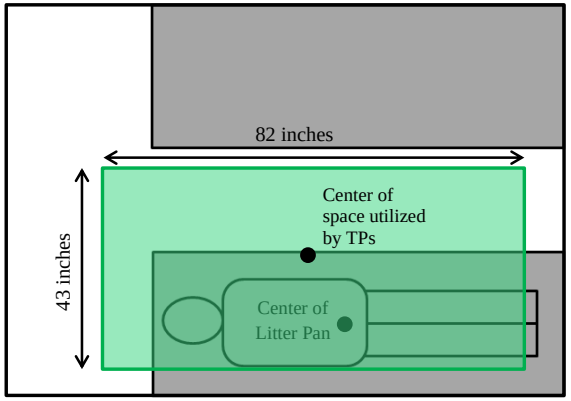


Results (Space Study, Phase 1)

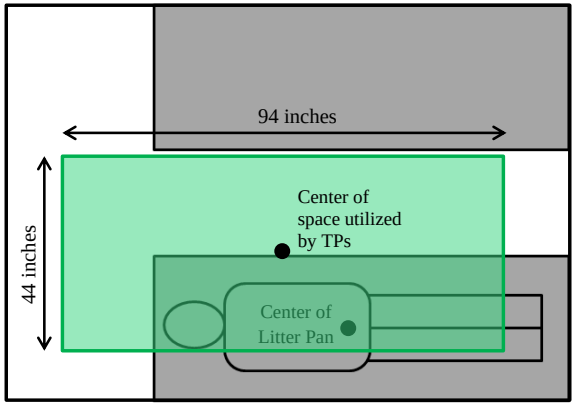
Lateral and Longitudinal Space Utilized



UH-60 Slick Floor



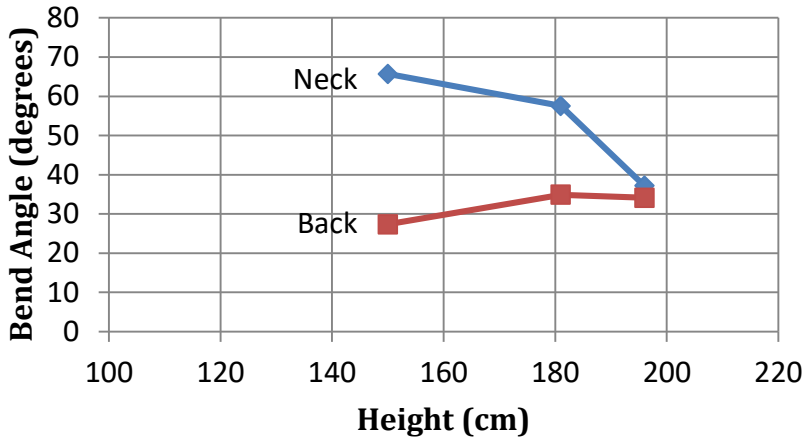
HH-60

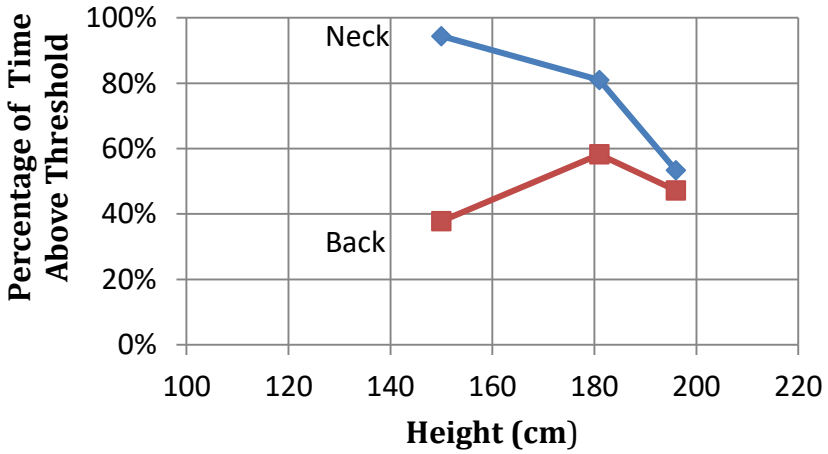


UH-60 w/ IMMSS

Results (Space Study, Phase 1)

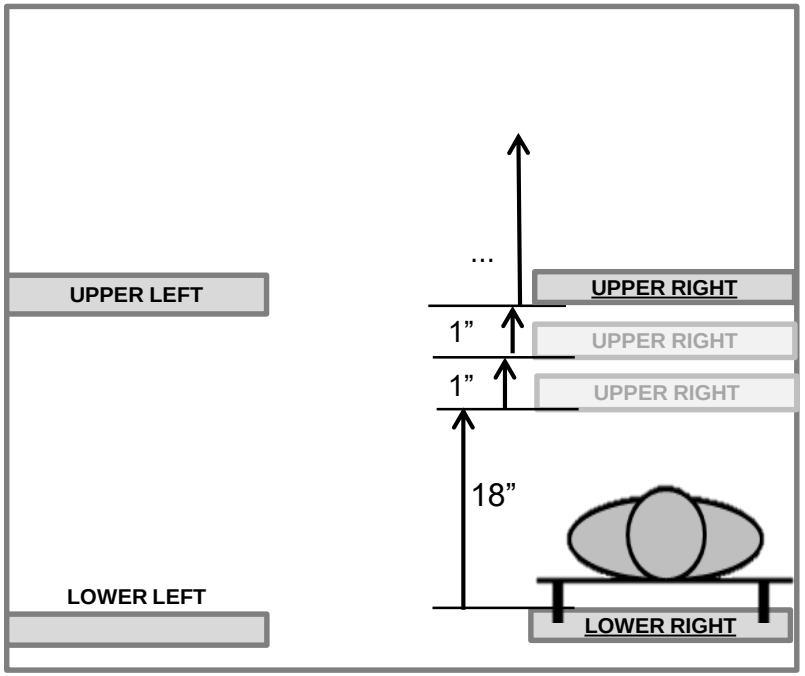
Average Bend Angles Among All Scenarios





Methods (Space Study, Phase 2)

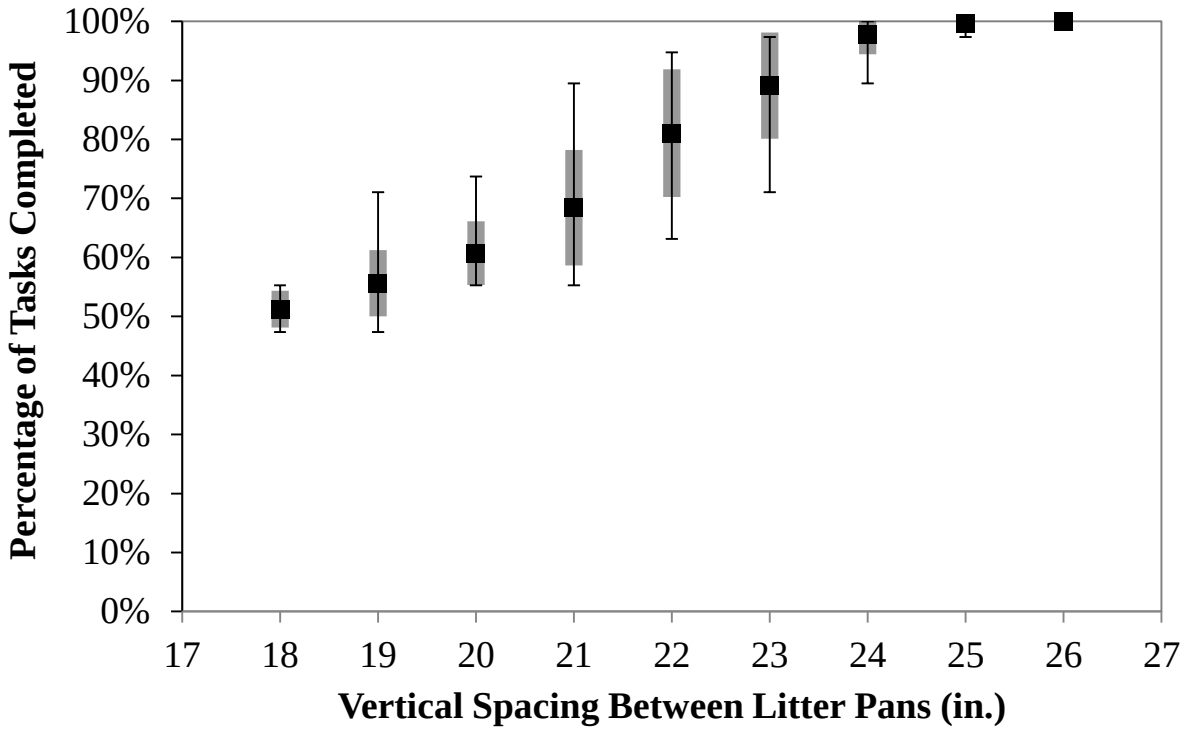
- Configuration: HH-60, at Fort Campbell with the 7th Battalion, 101st Aviation Regiment
- 15 paramedics/medics tested
- 43 medical tasks



Phase 2 - Test Participant Anthropometric Measurements and Percentiles

TP	Gender	Height (in.)	Percentile	Arm Span (in.)	Percentile	Weight (lb)	Percentile
1	M	72.25	90	72	55	158.6	**28**
2	M	74.5	98	77	95	274	**>99**
3	M	67.5	28	69	20	156.6	**24**
4	F	68	95	68	75	180	**98**
5	M	69	50	68.5	15	170	**47**
6	M	64	3	62	<1	187.4	**73**
7	M	75.5	>99	75	85	220	**95**
8	M	68.5	42	69.5	25	208.4	**91**
9	F	68	95	68	75	171.6	**95**
10	F	63.25	35	62	12	126.4	**30**
11	M	69.5	55	70	30	170.6	**48**
12	M	66.5	16	66.5	5	154.6	**22**
13	M	71	75	70.5	36	207.8	**91**
14	M	70	65	68.5	16	186.8	**72**
15	M	71	75	73.5	71	194	**80**

Results (Space Study, Phase 2)



Average percentage of tasks completed successfully, excluding task 27 (CPR), among all TPs (squares), standard deviation (rectangles), and data range (bars).

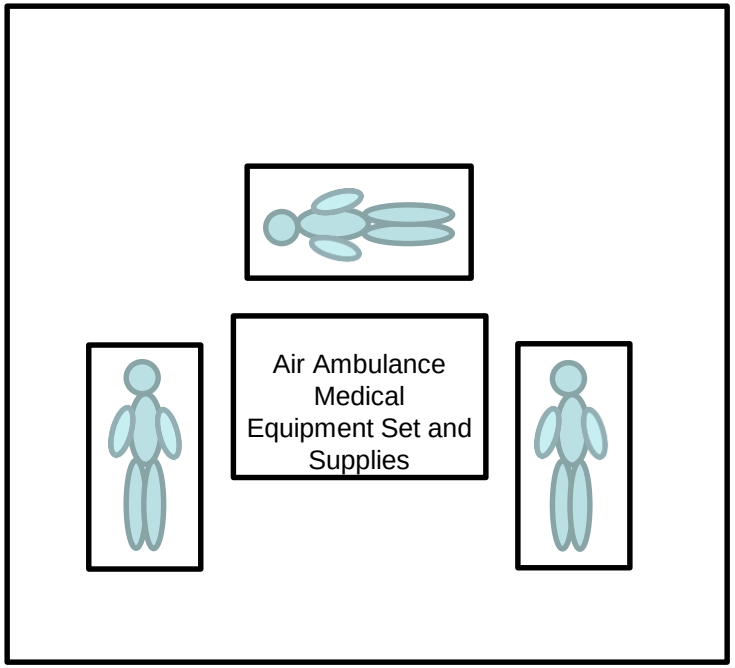
Task Saturation Study

Methods (Task Saturation Study)

- Sophisticated medical manikins (Laerdal Medical SimMan® 3G advanced patient simulator) that simulate various injuries and treatment outcomes
- Two groups of TPs: Greater and less than 24 months from the date of their CCFP certification
- Unconstrained configurations (*TPs* = 20)
- HH-60M configurations (*TPs* = 20)
- Medical Scenarios (30 minutes each) based on Joint Trauma Registry Point of Injury cases
- Audio recordings of aircraft white noise and general Internal Communications System (ICS) aircrew communications will be plugged to TP's ICS

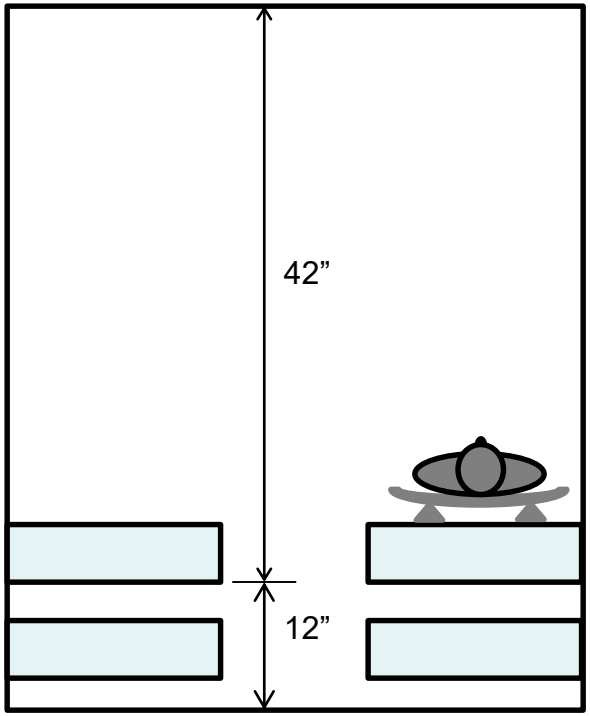
Methods (Task Saturation Study)

Unconstrained Configurations

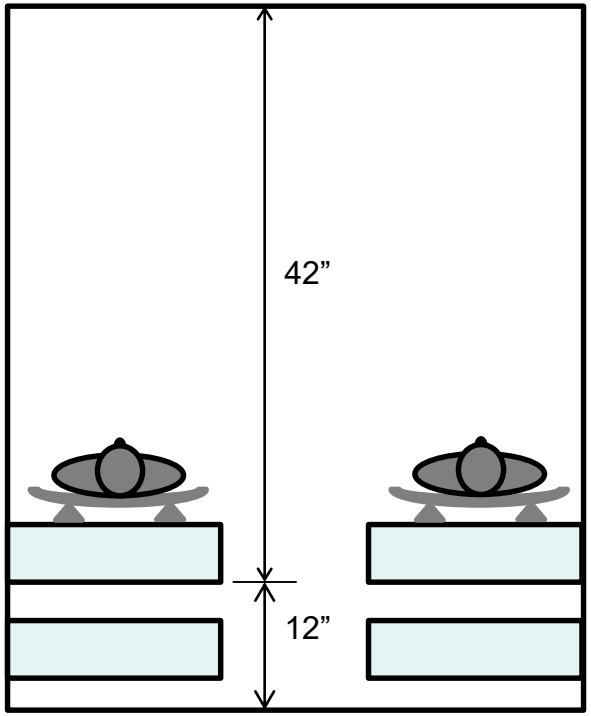


Methods (Task Saturation Study)

HH-60M Configurations



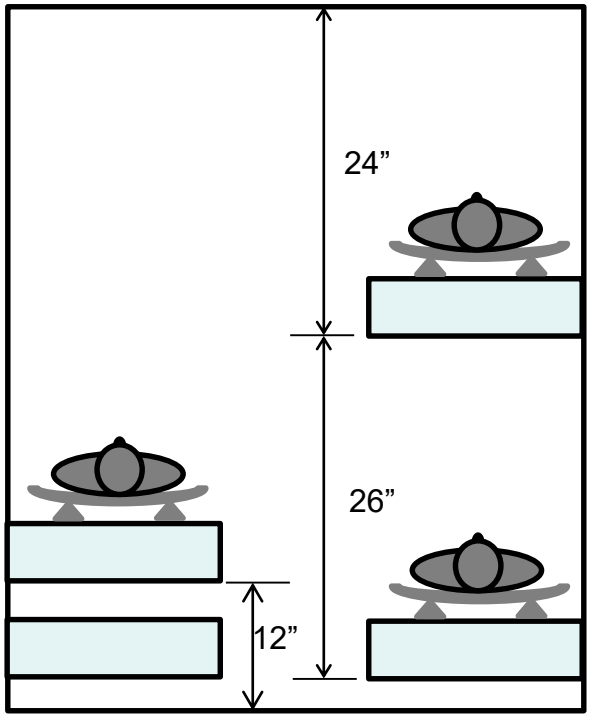
HH-60M One-patient Configuration



HH-60M Two-patient Configuration

Methods (Task Saturation Study)

HH-60M Configurations



HH-60M Three-patient Configuration

Discussion

- Based on the results, the vertical spacing of 18 to 24 in. (46 to 61 cm) between litter pans is inadequate for flight paramedics to successfully conduct life-saving treatment of casualties, regardless of platform type.
- The litter at an upper position (24 in., or 61 cm, below the ceiling) of the HH-60 resulted in more unsuccessful medical tasks compared to the lower position with the same vertical clearance.
- The test methods and data analysis provide a quantitative measure of evaluation criteria for developing and improving MEDEVAC aircraft interiors.
- Flight Paramedic's anthropometry and postures should be carefully taken into account for litter spacing.
- Task Saturation Study initial results suggest CCFP proficiency should be improved with more frequent training.

Conclusions

- A litter vertical clearance of at least 28 in. (71 cm) is recommended.

- More urgent patients should be positioned in the lower litter pan and less urgent patients should be loaded into the upper litter pan.

Questions?

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