



# From Sea to Air: Surgical Simulation in Extreme Environments



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## INTRODUCTION

The majority of combat deaths occur before reaching a surgeon or combat hospital.[1-3] To reduce preventable casualties, the authors examined the feasibility of operating on unstable platforms such as rapid transport vehicles which are capable of extracting wounded warfighters from austere environments. The feasibility of performing simulated operations was examined aboard a small, mobile ship and compared to US Navy team member's alertness, and psycho-motor skills during a 2 week voyage at sea.

## MATERIAL AND METHODS



Figure 1.) USS Brunswick



Figure 2.) USNS Brunswick Journey



Figure 3.) Cut Suit Manikin

- Three surgical teams were formed consisting of 15 active duty military members.
- Simulated surgeries were performed aboard the USS Brunswick underway from Norfolk, VA to San Diego, CA using "Cut Suit" technology developed by Strategic Operations Inc to simulate four common battlefield injuries:
  - Multiple fractures of pelvis
  - Abdominal Injury
  - Transverse fracture of femur
  - Partial traumatic amputation of lower leg
- Psychomotor vigilance task (PVT) assessments were provided to all members daily as a surrogate marker for alertness, problem-solving, and psycho-motor skills
- Each surgery was graded by subject matter experts on a Likert-type scale from zero to five with four or five deemed successful.

## RESULTS

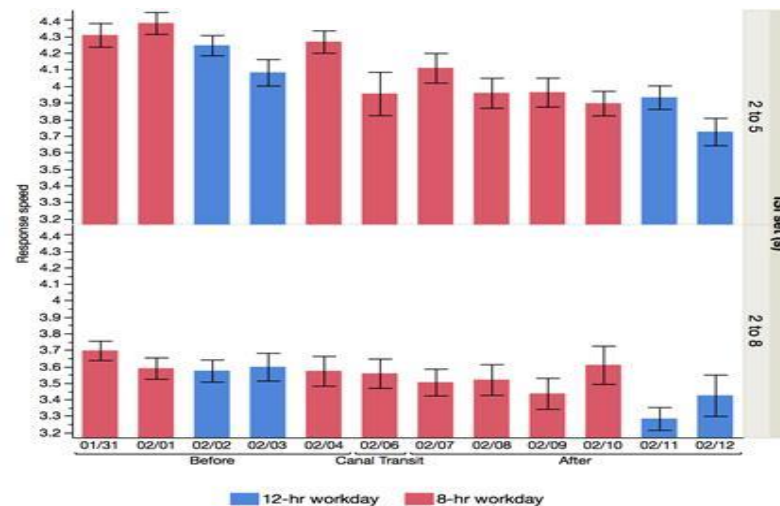


Figure 4. PVT response speed by day.

- 112 operations were performed with 46% completed at the roughest conditions tested.
- The amount of time spent underway was a predictor of sleep duration and psychomotor vigilance performance. Participants appeared to get adequate sleep but also appeared to experience test fatigue with the PVT procedures.
- The majority (89%) of resuscitative and surgical procedures performed met surgical SME criteria for successful patient outcome and therefore did not lend itself to definite and conclusive recommendations about the effect of fatigue and sleepiness on performance.
- The only significant predictor for patient outcome scores was which surgeon/team was performing the operation.

## DISCUSSION

### Conclusions:

- Ship motion did not significantly worsen surgical outcomes
- As psychomotor vigilance performances decreased, patient outcomes remained unchanged
- Surgical teams used a variety of techniques to stabilize themselves at sea
- All 15 participants reported that while the motion conditions made the resuscitative and surgical tasks more difficult, it did not prevent them from accomplishing the procedures.

### Future Research:

- Our next investigation will test the previous procedures in non-traditional aircraft, such as the V-22, a vertical take-off and landing tiltrotor aircraft currently used by the U.S military for casualty evacuation.
- Future research should also investigate the potential implications in the civilian sector for surgical stabilization in certain motion-induced trauma evacuation settings where immediate intervention is necessary.



## REFERENCES

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