

EN ROUTE CARE RESEARCH CENTER EVIDENCE TO GUIDE PRACTICE

Patients with Traumatic Brain Injury Transported by Critical Care Air Transport Teams: The Influence of Altitude and Oxygenation during Transport

Gaps: Per AE Research Program of Record by Core Capability Area (CCA), including specific research objectives (RO):

- Priority 4: Effects of flight on patients: CCA-Impact of Transport
RO: Determine the impact of flight during patient transport.
- Priority 6: Advanced POI and ERC Resuscitation: CCA-Clinical ERC
ROs: The effect of altitude on patients in the advanced POI and ERC resuscitation area, determine how much oxygen patients need.

Modified Abstract

Background: In the course of the Global War on Terror, the high prevalence of traumatic brain injury (TBI) has led to an intense focus on the effects of transport out of the combat zone on the injured. Survivability of previously devastating injuries has been increased by bringing highly trained US Air Force Critical Care Air Transport Teams (CCATT) in theater to evacuate the warfighters. However, the long-term effects of TBI can significantly impact the injured warfighter's quality of life. Management of TBI patients focuses on minimizing secondary cerebral insults, to include the prevention of hypoxia and hypotension. Aeromedical evacuation brings into question multiple variables, such as altitude and oxygenation levels, and their effects on TBI patient outcomes. Theoretically, patients may be at increased risk of secondary brain injury when transported at altitude. The combat injured are moved within the continuum of military care on various platforms—often via air—and the threat this poses for secondary insult to patients with TBI is poorly understood. We conducted a retrospective study evaluating the impact of cabin altitude restriction (CAR) during fixed wing aeromedical evacuation on patient oxygenation and outcomes in patients with moderate to severe TBI.

Methods: We queried the Department of Defense Trauma Registry (DoDTR) to obtain a list of patients who suffered a moderate to severe TBI and were transported out of combat theater to Landstuhl Regional Medical Center between January 2007 and May 2014. We defined moderate to severe TBI as an Abbreviated Injury Scale (AIS) severity score of the head/neck body region of 3 or greater with an ICD-9-CM diagnosis code for TBI from the CDC's Barell Matrix classification scheme. We categorized patients as having a CAR if they had a documented CAR or maximum cabin altitude of 5000 feet or lower in their CCATT record. We calculated descriptive statistics as well as univariate comparisons between the CAR and No CAR groups on demographics, injuries, preflight and in-flight interventions, in-flight events, and outcomes.

Results:

- We received DoDTR data for 3867 patients with TBI who were transported to Landstuhl Regional Medical Center between January 2007 and May 2014, of which 477 patients fit the study inclusion criteria.
- We excluded 39 patients with a catastrophic brain injury and 3 patients who were missing all CAR data, leaving a final sample of 435 patients for analysis.

- Of the 435 patients, 136 (31%) were in the CAR group (had a CAR or maximum cabin altitude of 5,000 feet or less) and the remaining 299 (69%) were in the No CAR group.
- 90% US active duty men, median age of 25 (IQR 21–30).
- Blast was the most common mechanism of injury (70%), 65% of patients sustained a penetrating injury, and 60% of patients had polytrauma. The median injury severity score (ISS) for the sample was 29 (IQR 21–35), 60% of all patients had a head/neck AIS severity score greater than 3, and 60% had a preflight Glasgow coma score (GCS) of 8 or lower.
- The most common in-flight events were body temperatures higher than 99.5°F (60% of sample), sodium levels lower than 145 mmol/L (46%), and systolic blood pressure lower than 110 mm Hg (44%). Nineteen percent of the sample had a PaO₂ lower than 80 mm Hg and 3% of patients experienced a SpO₂ lower than 93% while in flight.
- The overall survival rate for the sample was 96%. Most patients continued to receive medical care (89% of all patients) and 6% returned to duty or were discharged home.
- Thirteen percent of the sample was ventilated with a GCS score of 8 or lower at the time of discharge or transfer to another facility. Overall, survivors spent a median time of 15 days (IQR 6–33 days) in the hospital, 9 days (IQR 6–15 days) in the ICU, and 6 days (IQR 2–10 days) on a ventilator.
- We constructed Cox proportional hazards regression models to examine the independent association between CAR (yes versus no) and total hospital days, total ICU days, or total ventilator days while adjusting for possible confounders and censoring for mortality. Being flown with a CAR was not significantly associated with total hospital days, total ICU days, or total ventilator days in any of these models. Similarly, CAR was not associated with returning to duty or being discharged home, mortality, and poor discharge disposition in multivariable logistic regression models.

Conclusions: Patients with moderate or severe TBI who were evacuated with a recorded CAR had a lower rate of hypoxia during transport; however, they did not significantly differ from those who flew without a CAR with regard to mortality rates, hospital days, ICU days, or ventilator days.

Evidence Based Recommendations:

- Based upon our findings, we cannot recommend all moderate to severe head injury patients be transported using CAR. Medical personnel will need to use their clinical judgment and surrounding circumstances to determine if CAR is appropriate.

Publication

Maddry JK, Araña AA, Reeves LK, Mora AG, Gutierrez XE, Perez CA, Ng PC, Griffiths SA, Beberta VS. Patients with Traumatic Brain Injury Transported by Critical Care Air Transport Teams: The Influence of Altitude and Oxygenation during Transport. *Mil Med.* 2020;185(9/10):e1562-e1568. <https://pubmed.ncbi.nlm.nih.gov/32515785/>

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