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Original Contributions

PROSPECTIVE OBSERVATIONAL STUDY OF UNITED STATES (US) AIR FORCE CRITICAL CARE AIR TRANSPORT TEAM OPERATIONS IN IRAQ

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□ **Abstract—Background: Current United States (US) military doctrine emphasizes rapid evacuation of casualties to fixed medical facilities remote from the theater of war. To support this strategy, the Air Force has formed Critical Care Air Transport (CCAT) teams consisting of a physician, nurse, and respiratory therapist. Study Objective: To describe the characteristics of US Air Force CCAT team operations at Balad Air Base, Iraq over a 1-year period. Methods: Balad Air Base was the primary collection point in Iraq for patients requiring evacuation outside of the country during the study period. The study authors deployed sequentially to Balad Air Base as CCAT team leaders. All patients transported by the authors were enrolled in the study. Injuries, illnesses, demographics, and in-flight data were collected prospectively. Results: There were 133 patients transported on 61 separate flights between Iraq and Germany. Trauma was present in 65% (87/133) of all patients transported. Lower-extremity injuries were the most prevalent among combat-related trauma patients. Cardiac conditions were the most common diagnoses among the medical patients. Fifty-seven percent of patients were mechanically ventilated. Hypotension was the most common in-flight complication, occurring in 17% (22/133) of patients. No flights were diverted or turned back due to an unstable patient. No patient died during flight or in the 24 h after the flight. Conclusions: US Air Force CCAT teams can safely transport multiple critical patients over long distances while providing intensive care interventions. Medical patients make up over one-third of patients requiring CCAT team transport. Published by Elsevier Inc.**

□ **Keywords—military medicine; aeromedical transport; Iraq; transport medicine; critical care air transport**

Preliminary results of this study were presented at the American College of Emergency Physicians Scientific Assembly, New Orleans, LA, October 2006, and published as an abstract in the *Annals of Emergency Medicine*.

INTRODUCTION

Previous United States (US) military medical doctrine emphasized placing large, robust medical treatment facilities in or near the theater of war. Patients were treated over an extended period in these facilities until they could be returned to duty or were stable for aeromedical evacuation to the US (1). Under this system, large numbers of patients were cared for in flight by an aeromedical evacuation crew consisting of two flight nurses and three medical technicians. The size and composition of the crew could be modified depending on the number and acuity of patients, but there was a lack of equipment and trained personnel to care for critical patients. Physicians were infrequently present on aeromedical evacuation flights (2).

In the mid-1990s, the US military adopted a more mobile medical model that placed small surgical teams close to the battlefield and emphasized rapid evacuation (1,3). Today, patients receive damage control surgery in the theater of war and are then rapidly evacuated to larger

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medical facilities that frequently are thousands of miles away. To meet the need for rapid evacuation of critically ill patients over extended distances, the US Air Force developed specialized critical care air transport (CCAT) teams. CCAT teams augment standard aeromedical evacuation crews when critical patients are transported.

Each CCAT team is designed to be an independently functioning mobile intensive care unit capable of providing in-flight critical care for three mechanically ventilated patients (4,5). The teams consist of a physician who has completed a critical care fellowship or frequently cares for critical patients (emergency medicine, anesthesia, cardiology, or general surgery), a critical care nurse, and a respiratory therapist with recent experience in a critical care setting. All team members attend a 2-week course that emphasizes aeromedical physiology, aeromedical evacuation procedures, and aircraft safety.

The CCAT team concept has proven to be flexible and extremely successful. Since its inception, CCAT teams have responded to international emergencies, evacuated critically injured sailors after the bombing of the USS Cole in 2000, and responded to natural disasters including Hurricanes Katrina and Rita in 2005 (6–8).

Hurd et al. have reported that CCAT teams were required for 9.8% of all battle injuries and 1.26% of all casualties transported from Iraq and Afghanistan during fiscal years 2002–2005 (5). Despite the extensive use of CCAT teams in Afghanistan and Iraq, limited data have been published describing their employment in the setting of war, the types of injuries, the patient acuity, or in-flight events.

Our objective was to describe the patient demographics, injury patterns, and in-flight course of all patients transported by three CCAT teams from Balad Air Base, Iraq to Landstuhl Regional Medical Center, Germany over 1 year.

METHODS

We conducted a prospective, observational study of patients transported by US Air Force CCAT teams from Balad Air Base, Iraq to Landstuhl Regional Medical Center, Germany during the time period of September 2005 to August 2006.

During the study period, the Air Force Theater Hospital (AFTH) at Balad Air Base was the primary collection point in Iraq for patients requiring evacuation outside of the country. Patients arrived at the AFTH directly from the field, or were flown there on rotary or fixed-wing aircraft after receiving initial care at another medical facility in Iraq.

The study authors are all board-certified emergency physicians who were deployed separately to Balad Air Base as CCAT team leaders. Each author deployed sequentially with his team, leaving no temporal gap in enrollment during the study period. There were four or five CCAT teams in Balad transporting patients on a rotating basis throughout the study period. One of these teams was always led by one of the three study authors. When the AFTH had patients needing transport, a request was submitted to a remotely located control center. The center then assigned the transport to the next team in the rotation. Upon completion of the transport, the team would return to Iraq and be placed at the end of the rotation. Transports were evenly distributed among the teams, and patient or team characteristics did not influence the assignment of transports. All patients transported by teams led by the authors comprise the study population.

At the time of initial patient contact, the authors recorded injuries, illnesses, and demographics on all patients they transported. Data sources included the CCAT physician examination, patient studies, medical records available at the time of transport, and verbal reports from the transferring physician. In-flight interventions, complications, and equipment failures were collected and recorded by the authors during the flight. All data were recorded on a standardized data collection form designed for this study. Each author followed his own patients for the occurrence of death within 24 h by ongoing communication with receiving physicians and by attendance at morbidity and mortality conferences that covered all patients transported out of Iraq.

All patients were categorized as having either a primary trauma or medical diagnosis. Trauma patients were further divided into those sustaining trauma from combat-related activities (e.g., gunshot wounds, mortar attacks, improvised explosive device "roadside bomb" injury) vs. non-combat injuries, such as falls or accidents unrelated to combat duties.

Injury severity scores (ISS) were calculated for all combat-related trauma patients. The ISS has been shown to correlate fairly well with mortality and multisystem organ failure (9,10). It is the most widely used anatomic trauma scoring system but has several shortcomings, including failure to account for physiologic variables or multiple injuries to the same body region. An ISS > 15 is generally considered to represent severe trauma (10).

Data were stored and queried in Microsoft Access (Microsoft Corporation, Redmond, WA) and statistical analyses were done in EpiInfo v.3.4.1 2007 (Centers for Disease Control and Prevention, Atlanta, GA). Age data were compared using the Mann-Whitney U test and categorical variables were analyzed with the chi-squared test or Fisher's exact test.