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In by helicopter out by cab: the financial cost of aeromedical overtriage of trauma patients

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ABSTRACT

Background: Helicopter transport of injured patients is controversial and costly. This study aims to show that a complex trauma algorithm leads to significant aeromedical overtriage at substantial cost. Our secondary outcomes were to compare adjusted mortality and outcomes between air and ground transport and determine predictors of overtriage.
Materials and methods: A 6-y retrospective analysis was conducted of all trauma activations at a Level I center. Patients were dichotomized by transportation method as well as trauma activation criteria. Overtriage was defined as those who were discharged from the emergency department, medically admitted without injuries, or admitted to observation status only. Overtriage and associated charges were calculated for each patient cohort, and multivariate regression models were created to derive adjusted mortality rates and predictors of overtriage.
Results: A total of 4218 patients were treated with 28% arriving by helicopter. Overtriage increased significantly from 51% to 77% with lower tier activation criteria ($P < 0.001$). Median charges for air-evacuated patients was $10,478 (*versus* $1008 ground). Eliminating overtriage of air patients would result in a cost savings of $1,316,036 annually. Adjusted mortality between air and ground transport was not significantly different (8.5% *versus* 10.9%, $P = 0.548$). Predictors of overtriage included decreasing age, Injury Severity Score, Head Abbreviated Injury Score, nonoperative treatment, and lower tier activation criteria.
Conclusions: Significant overtriage (52%) and unnecessary air evacuation of minimally injured patients occurs at great financial cost. Revision of trauma activation protocols may result in more judicious air transport use and significant reductions in health care costs.

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Introduction

Aeromedical evacuation of trauma patients is a potentially lifesaving intervention targeted to benefit those with severe injuries. The first use of helicopter transport was in 1945 to carry injured army troops from Burma. This was expanded during the Korean War and was soon adopted as the primary method of transportation within the military. As the mid-1960s arrived, helicopter transport became widely used for civilian regional trauma care in the United States[1,2] and continues to be a staple resource for many trauma centers across the country.

Although helicopter transport is not a method of treatment, it reduces patient time outside of the hospital, theoretically allowing for faster delivery of definitive care in the "golden hour." The best data to support air transport of the injured come from highly select patient populations. Air transport for patients with severe injuries that are physiologically unstable have demonstrated improved survival over ground transportation in urban environments.[3-7] This is also true for patients in larger rural geographic areas, where ground transport can greatly increase out of hospital time, because of distance from scarce trauma resources.[8] Large burns may also benefit from immediate air transport because of the highly specialized nature of care required for these injuries, as well as the widespread distribution of burn centers in the United States. Progressive burn shock, pulmonary dysfunction, compartment syndromes, and burn wound infections are complications which can be avoided by expedient aeromedical transport.[9,10]

Aeromedical evacuation is useful for these select patient populations and overuse of helicopter transport in less severely injured patients is both controversial and costly. Various studies have criticized the standards for current use of aeromedical transport, especially in scene evacuation within the urban setting or in rural environments for patients with minimal injury burden.[11-13] Much of the criticism of flight programs originates from the high costs associated with each transportation and yearly maintenance. Average helicopter transfer costs have been reported to range from $5000 to $18,000 per flight,[11,14] whereas the annual maintenance costs range from hundreds of thousands of dollars to $4.5 million per year.[15]

Although mortality may be reduced by aeromedical transport, it comes at great financial cost, $325,000 per life saved in one estimate,[16] and should therefore be applied judiciously. We therefore sought to perform a thorough analysis of our current aeromedical transport efficacy and cost expenditures at our urban Level I trauma center. We specifically aimed to identify the rate of helicopter overtriage using our complex trauma activation algorithm and the associated financial costs. Our secondary outcomes were the comparison of adjusted mortality rates between air and ground transport as well as predictors of overtriage.

Material and methods

This was a retrospective registry study from an urban Level I trauma center in Palm Beach County, Florida. Palm Beach County encompasses an area of just under 2400 square miles with a population of approximately 1.4 million citizens and has its trauma care provided by two state-verified Level I trauma centers. We examined patients admitted as trauma alerts from 2011 to 2015. Patients were abstracted from the registry if they were aged >18 y. Patients were excluded from the analysis if they had nonsurvivable injuries (Injury Severity Score [ISS] = 75 or Abbreviated Injury Score [AIS] in any body region = 6), burns as primary mechanism of injury, missing data, or that were deemed dead on arrival. Overall, 3.4% of patients in our population were dead on arrival or died in emergency department (ED). This constituted 3.2% in the ground group and 3.9% in the air transport group and was not significantly different ($P = 0.233$). Because of the high likelihood of futility in these cases as well as the equal distribution between transport methods, we felt justified in excluding these patients. Various patient demographic characteristics were taken from the registry and included age, gender, ethnicity, primary insurance status, as well as comorbidity index as defined by Charlson.[17] Admission physiology and injury severity were also abstracted and included mechanism of injury, systolic blood pressure (SBP), Glasgow Coma Score (GCS), body region AIS, ISS, type of injury sustained, as well as need for immediate operative interventions. Hospital disposition, need for intensive care unit (ICU) admission, and in-hospital mortality were also tracked.

Our primary outcomes of interest were the rate of overtriage of aeromedical flights and their associated transport costs. Overtriage was defined as patients who were discharged directly from the ED, admitted to a medical service without any injuries, or who were admitted to observation status as defined by current Medicare guidelines[18] (i.e., a hospital length of stay of <48 h). Our secondary outcomes were the estimated costs of transporting patients via air *versus* ground, annual costs savings realized by eliminating aeromedical overtriage, and adjusted mortality between air *versus* ground transport. To estimate the transport charges of patients brought to our facility, the current Palm Beach Fire Rescue ambulance transport charge of $800 plus $12 per mile was used for ground arrivals, whereas the Palm Beach County Healthcare district charges $9838.05 plus $60.93 per mile for aeromedical transport. The mileage distance was calculated using the average ground speed of the vehicle during flight/drive divided by the transportation time, as the exact location of pickup was unavailable from the trauma registry.

Our complex trauma algorithm (Table 1) is loosely based on Centers for Disease Control and Prevention criteria and includes red (physiological), blue (mechanistic), and gray (county/paramedic judgment) groups, respectively. The decision to call aeromedical evacuation is at the discretion of Emergency Medical Services (EMS) providers on scene and fall into three broad criteria: (1) nearest trauma center is >20 min away, (2) ground transport unavailable in a "reasonable amount of time," and (3) >15 min of extraction time required. Univariate testing was then performed on all independent demographical and physiological variables to identify differences in the patient populations.

For statistical analysis, all patients were stratified according to transport status, ground *versus* air, as well as trauma