# Spinal Cord Injuries and Helicopter Emergency Medical Services, 6,929 Patients: A Multicenter Analysis

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## Abstract

**Objective:** Traumatic spinal cord injury (SCI) impacts quality of life for patients and caregivers, generating lifetime costs in the millions. Previous studies show delayed treatment of SCI patients at specialized centers is linked to complicated outcomes and extended hospitalizations. This study characterizes helicopter emergency medical service (HEMS) use in SCI and develops a methodology to study large volumes of HEMS electronic medical record data from multiple providers.

**Methods:** This descriptive study used deidentified data of HEMS providers that use Golden Hour Data Systems, Inc (San Diego, CA) software service from 34 states in the United States from 2004 to 2011. Demographic and logistical data underwent a deidentification protocol developed specifically for this study before analysis.

**Results:** Six thousand nine hundred twenty-nine SCI patients were transported. HEMS use increased but decreased relative to total transports from 2004 to 2011. The average patient was 39 ± 21 years old, male, and had a 63-minute total transport time. The largest age bracket was 15 to 25 years.

**Conclusion:** HEMS improved access for SCI patients to all localities and generally took under 2 hours. SCI patients are mostly young adult males, thus supporting the loss of years of productivity and also supporting the high lifetime cost for care for SCI. This study created a methodology for future multicenter aggregate data studies.

## Introduction

Spinal cord injuries (SCIs) are devastating traumatic injuries that can result from direct damage to the spinal cord or from injury to the surrounding bony structures.[1,2] Current estimates predict that SCIs affect between 236,000 and 327,000 persons in the United States. Approximately 12,000 people per year in the United States suffer a traumatic SCI that severely affects their quality of life as well as placing a burden on their caregivers and health care systems.[3] The financial impact to society is severe. Only 52% of individuals suffering from SCIs are covered by private health insurance at the time of injury, and the average lifetime care cost for quadriplegics injured at age 25 hovers around $4.5 million. Thus, strategies that minimize the long-term neurologic effects can make an enormous fiscal difference for all involved.[2,4] Highlighting the importance of rapid transport to a qualified SCI treatment center, previous studies show that delayed admission of spinal-injured patients to a recognized spinal injuries specialty care center has been reported to increase both the incidence of complications, such as contractures and pressure ulcers, and the length of hospitalization.[5-6]

Much of the benefit of air medical transport over ground transport systems is predicated on time saving and the ability of helicopter emergency medical services (HEMS) to move patients directly to definitive care over long distances and adverse terrain. HEMS have become a vital link for time-dependent and specialty care illness in modern tertiary health care systems.[7] In a 2005 *JAMA* article, it was shown that without HEMS only 27% of the US population would have access to level I or II trauma centers within the "golden hour," a time frame that makes a difference in some trauma patients.[8] No similar large-scale demographic and logistical analysis has been done for SCI. It has been shown that decreased transport time and level of care provided by HEMS can increase the survival rate of patients transported to level 1 and 2 trauma centers; presumably, some of these would be SCI patients.[9,10] For interfacility transports, it has been shown that HEMS can reduce transport times by 10 to 45 minutes compared with ground transport.[11] Because of the lack of qualified critical care ground transport in rural and super-rural localities, often HEMS is the only means of moving these critical patients. What is less studied is the importance of prompt and specialized medical intervention brought to the patient by HEMS, specifically in traumatic SCI. HEMS often plays a vital role in the care of these unfortunate patients. Because these patients are young, the injuries are devastating, and it is generally believed that HEMS has a high value to the injured person as well as society, the concept of system necessity requiring patient transport by HEMS is not well studied or understood.

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We present a demographic study of SCI patients transported by HEMS on an unprecedented scale, analyzing integrated information gathered by 67 clients of the largest HEMS information systems provider in the United States, Golden Hour Data Systems Inc, San Diego, CA. In collaboration with the Air Medical Research Institute established at the university, over 800,000 patients were deidentified (in compliance with US privacy regulations) to develop a large diagnosis-related data set, from which the SCI data subset was created. Almost 7,000 SCI patients were transported by HEMS from 2001 to 2011. Over 30 unique data fields were entered into the Golden Hour Data Systems Inc transport database for each SCI patient including patient demographics, transport logistics, and standardized diagnoses. Patient demographic data included age, sex, location, locality[12] designation, and patient race. Transport logistics represented the majority of data and included transport times, sending scene or facility capability, receiving facility capability, and so on. Finally, standardized diagnoses representing a list of clinical impressions based on *International Classification of Diseases, Ninth Revision* (*ICD-9*) reason for transport, text-based impressions, and "nature of transport" diagnosis selection systems were used to create the SCI data subset. Patient outcome after transport is not included in the Golden Hour dataset, and outcome linkages to trauma registries at each of the hundreds of receiving institutions was beyond the scope of this study. The study aimed primarily to characterize the data within this data set and then facilitate a better understanding of the role of HEMS in traumatic SCI cases at a US national level. This was achieved by outlining trends and relationships within the demographics, transport logistics, and standardized diagnoses data. Data presented herein provide insight into current strategies for HEMS among various population subsets as well as improves the understanding of the impact HEMS has on SCI treatment.

## Methods

### *Data Set*

This study was approved by the university institutional review board. All data were collected with integrated software as a service electronic medical record (EMR) from Golden Hour Data Systems, Inc during HEMS patient documentation by multiple clients over a 6-year period. Clients increased throughout the study, and at the end of the study, over 67 separate programs contributed. This EMR service integrates clinical and dispatch data on "cloud-hosted" servers managed by the EMR provider. All data are owned by the emergency medical services (EMS) providers who agreed contractually to a deidentified data sharing protocol through the EMR provider, thus permitting academic research. Golden Hour's cumulative client deidentified database consists of 861,284 rotor transports between 2004 and 2011. From the total data set, 6,929 of the patients were assigned *ICD-9* codes, *ICD-9* text, or reason for transport consistent with SCIs, isolated with the assistance from a certified medical coder. Patients studied were between the ages of 1 and 99 and were transported by HEMS between 2004 and 2011. Fixed wing transports and ground transports were excluded. Patients with relevant missing or incorrect data were excluded from the study as well as nontraumatic SCI patients. This represented less than 1.3% of the data set for SCI.

### *Demographics and Logistical Measures*

Patients are described in terms of age, sex, and race. Logistics including pickup location, transport distances, transport times, and time of day were also studied. Statistics concerning transport times, transport distance, locality, and geographic frequencies were studied with respect to differential distributions of scene and interfacility transports. Missing or inaccurate US postal codes were derived from global positioning system coordinates using Google Maps (Google, Inc, Mountain View, CA). Zip codes were then matched with the US Department of Agriculture's definition of rural, super-rural, and urban environments collectively defined as localities to comply with the deidentification protocol. Zip code and global positioning system coordinates thereafter were excluded to comply with US privacy regulations related to protected health information.

### *Time-dependent Care*

In this study, we measured the average transport times in urban, rural, and super-rural settings (locality) and classified these times further based on scene or interfacility transports. Times were measured by helicopter and dispatch crews using information system times that are electronically synchronized to US standardized times and the atomic clock.

### *Scene and Interfacility Mission Definitions*

Scene transports, or missions, were defined as dispatch to a non–health care facility that occurred before hospital-based evaluation and interfacility transports or missions involving dispatch to a sending health care facility for purposes of transport to a second health care facility. Scene and interfacility designations are collectively termed mission type in this study.

### *Transport Times and Temporal Trends*

Total transport times were defined as the difference between receipt of call for a helicopter and arrival of the transport at the receiving facility. The time of injury and prehospital treatment were not reliably reported so total transport time only identifies the minimum time from injury to patient arrival at a hospital and not the actual time from injury to arrival at the hospital.

Average transport times and distances in the different localities (urban, rural, and super-rural) as well as scene and interfacility transports were studied to understand access to care issues. Response time, defined as the length of time from the dispatch call to the time the aircraft departed the sending facility, was used to assess if there was adequate access to HEMS for