Prehospital Glasgow Coma Score Predicts Emergent Intervention following Helicopter Transfer for Spontaneous Subarachnoid Hemorrhage

Jennifer Hong[1], *Sebastian Rubino*[2], *Stuart Scott Lollis*[1]

■ BACKGROUND: **Helicopter transport may shorten transport time to neurosurgical intervention; however, there are few data regarding its utility for nontraumatic emergencies.**

■ METHODS: **Prehospital and hospital records of all patients transferred via helicopter to Dartmouth-Hitchcock Medical Center for spontaneous subarachnoid hemorrhage between January 2007 and December 2011 were reviewed. Primary outcome measure was emergent tertiary-level care intervention, defined as ventriculostomy, conventional angiography, endovascular treatment, or craniotomy within 3 hours of arrival.**

■ RESULTS: **Fifty-one patients met inclusion criteria. Median helicopter transport time, defined as time from telephone referral to arrival, was 97 minutes (range, 61—214 minutes). Fifteen patients underwent intervention within 3 hours of arrival (29%), 19 patients underwent intervention between 3 and 6 hours (37%), 9 patients underwent intervention between 6 to 12 hours (18%), and 11 patients underwent intervention greater than 12 hours after arrival (16%). Univariate analysis of pretransfer clinical and radiographic findings showed significant correlations between Glasgow Coma Scale (GCS) score less than 15 (odds ratio [OR], 22.8; 95% confidence interval [CI], 4.2—122.5), World Federation of Neurologic Surgeons (WFNS) scale greater than 2 (OR, 46.75; 95% CI, 7.511—290.99), presence of intraparenchymal hemorrhage (OR, 4.7; 95% CI, 1.3—17.5), and intubation (OR, 12.4; 95% CI, 2.9—51.8) with emergent intervention. On logistic multivariate regression analysis, GCS score less than 15 and WFNS scale score greater than 2 independently predicted emergent intervention.**

■ CONCLUSIONS: **A majority of patients with spontaneous subarachnoid hemorrhage who were transferred by interfacility helicopter ambulance did not require emergent intervention. GCS score less than 15 at an outside hospital was independently associated with emergent intervention on multivariate analysis.**

INTRODUCTION

Since the initial use of air ambulances to evacuate wounded soldiers in World War I, helicopter and other airborne transportation of patients has become increasingly popular in both military and civilian contexts.[1] Between 1999 and 2008, the number of patients transported by helicopter increased by 35%; the number of dedicated air ambulance helicopters increased from 360 to 677, an 88% growth.[2] In 2007, 16% of transports from the scene to a trauma center in a national trauma database were by helicopter.[3]

Despite its escalating use, there is little evidence regarding the benefits, risks, and costs of helicopter emergency medical services (HEMS). To date, there are no randomized controlled trials for

Key words
- Aneurysm
- Helicopter EMS
- Hydrocephalus
- Interfacility transfer
- Spontaneous subarachnoid Hemorrhage

Abbreviations and Acronyms
BCI: Bicaudate index
CI: Confidence interval
CT: Computed tomography
DHART: Dartmouth-Hitchcock Advanced Response Team
DHMC: Dartmouth-Hitchcock Medical Center
GCS: Glasgow Coma Scale
HEMS: Helicopter emergency medical services
IPH: intraparenchymal hemorrhage
MFS: Modified Fisher scale
OR: odds ratio
SBP: Systolic blood pressure
SD: Standard deviation
sSAH: Spontaneous subarachnoid hemorrhage
TBI: Traumatic brain injury
WFNS: World Federation of Neurologic Surgeons

From the [1]*Section of Neurosurgery, Department of Surgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, USA; and* [2]*Department of Neurosurgery, Albany Medical College, Albany, New York, USA*

To whom correspondence should be addressed: S. Scott Lollis, M.D. [E-mail: S.Scott.Lollis@hitchcock.org]

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ground versus air transport of patients. Of the nonrandomized studies that have been done, most have focused on traumatic injury and direct scene calls, in particular. Although some studies have demonstrated that helicopter transport is associated with improved outcomes,[3-6] others have concluded that there is not a significant clinical benefit and that this resource is substantially overused.[7-11] A Cochrane review stated that the benefit of HEMS could not be determined for adults with major trauma.[12]

There has been even less investigation of inter-facility helicopter transport of nontraumatic neurologic emergencies, although these injuries might require time-sensitive evaluation and intervention and are often drivers of HEMS utilization. Spontaneous subarachnoid hemorrhage (sSAH) is a neurosurgical indication for transfer to a tertiary care center. Patients with sSAH are at risk for sudden deterioration, either from aneurysm re-rupture or hydrocephalus. These patients are frequently selected for expedited transfer by referring physicians, assuming travel times are faster for helicopter compared with ground transport, and often arrive by air to the accepting institution; however, many patients with sSAH are clinically stable and require only close neurologic monitoring until definitive treatment. These latter patients are unlikely to benefit from HEMS.

Helicopter EMS in a rural setting is a limited and costly resource. Flying patients with sSAH who can be transferred safely by ground is not only expensive it also diverts a helicopter that might be needed for other medical emergencies. There are no guidelines for discerning which patients with sSAH are likely to require emergent intervention and which patients with sSAH are stable, raising the possibility that HEMS is overused or underused in this patient population. We undertook a 5-year retrospective review of all inter-facility HEMS transfers of patients with sSAH to determine whether the use of air transport was appropriate and preceded emergency tertiary neurosurgical interventions. Our goals were threefold. First, describe the transport timeline and pretransfer clinical and radiographic presentations for patients with sSAH. Second, describe the posttransfer interventions of these patients. Third, assess whether prehospital clinical or radiographic data associated with emergent intervention could be identified.

METHODS

Participants and Study Design

Following approval by the Dartmouth Institutional Review Board, hospital records, outside hospital imaging studies, and the Dartmouth-Hitchcock Advanced Response Team (DHART) database were queried for patients who were transported by helicopter to Dartmouth-Hitchcock Medical Center (DHMC) for neurosurgical evaluation between January 1, 2007, and December 31, 2011. A diagnosis of subarachnoid hemorrhage was based on hospital discharge documentation and referral information.

Description of Air Ambulance System

Dartmouth-Hitchcock Medical Center is a level I trauma center and tertiary referral center for northern New England. Our referral region encompasses 22 hospitals that routinely transfer patients to DHMC for neurosurgical evaluation and care. DHMC operates a helicopter ambulance program called DHART. Two helicopters, one stationed at DHMC and another in Concord, a city approximately one hour south of DHMC, are in operation 24 hours a day, 7 days a week, weather permitting. A DHART flight crew consists of a pilot, and two intensive care unit nurses.

Mechanism of Transfer

Currently, protocols for inter-facility helicopter transport of patients stipulate that the "Responsibility for the patient transfer lies with the transferring physician/provider, and must take into account the risks versus benefits to the patient." Therefore, the decision to transport by helicopter is made by the referring physician.

Clinical Variables and Outcomes Assessment

Clinical data were retrieved through retrospective chart review. Data included age, sex, presenting symptoms, clinical examination results, vital signs, Glasgow Coma Scale (GCS) score, radiographic studies (including outside hospital imaging when available), transport time, interventions, time to intervention, hospital length of stay, and disposition. All patients who were transferred to DHMC for evaluation of sSAH, as stated in the transfer note, were included. In addition, chart review was undertaken to identify patients who had sSAH as a discharge diagnosis but were classified under a generic category, such as "neurologic injury."

We did not include Hunt-Hess grade as a pretransfer clinical variable because documentation of this grade was inconsistent among referring emergency department providers, and retrospective calculation was unreliable. GCS is routinely scored as part of the pretransfer examination, and we chose this score as our principle pretransfer clinical variable because it has been validated as an alternate predictor of outcome in aneurysmal SAH.[13,14] The World Federation of Neurologic Surgeons (WFNS) grading scale[15] was calculated based on documented GCS and the neurologic examination recorded in the transfer note.

CT scans performed at outside hospitals at initial presentation were obtained for central review, and all patients underwent repeated head CT imaging upon arrival at DHMC. Pre-transport and post-transport CT images were reviewed for modified Fisher grade,[16] presence of intraparenchymal hemorrhage (IPH), evidence of rebleeding, maximal temporal horn diameter, bicaudate index,[17,18] and midline shift. Hydrocephalus was defined as a bicaudate index greater than the age-corrected 95th percentile.[17,18]

The primary outcome measure was time to neurosurgical intervention. Time to intervention was calculated based on the time of arrival documented in the DHART flight log, the procedure start times on anesthesia operating room logs and procedure time documented in the electronic record for ventriculostomy placement. Neurosurgical intervention was defined as ventriculostomy, formal angiogram, or craniotomy. An intervention was classified as emergent if it occurred within 3 hours of arrival to DHMC. Three hours is the maximum amount of time required to transport a patient from the furthest hospital in our referral region by ground ambulance (in other words, the longest period that a patient waited for intervention if the helicopter was not available). The secondary outcome measures were neurosurgical interventions, disposition from the hospital, and overall survival. Average drive times were calculated using Google Maps, designating a one-way trip. When multiple routes were available, the route with the shortest time was chosen.