Transfer Time to a High-volume Center for Patients with Subarachnoid Hemorrhage Does Not Affect Outcomes

Thomas J. Wilson, MD,*[1] Yamaan Saadeh, MD,*[1] William R. Stetler, Jr, MD,* Aditya S. Pandey, MD,* Joseph J. Gemmete, MD,† Neeraj Chaudhary, MBBS,† B. Gregory Thompson, MD,* and Jeffrey J. Fletcher, MD*†

Objectives: The objective of our study was to examine patients with aneurysmal subarachnoid hemorrhage transferred and directly admitted to our institution in order to determine how transfer time affects outcomes. *Methods:* A retrospective cohort study was performed of all patients undergoing treatment for aneurysmal subarachnoid hemorrhage between 2005 and 2012 at the University of Michigan. Variables, including transfer time, were tested for their independent association with the primary outcomes of symptomatic vasospasm and 12-month outcome as well as secondary outcomes of aneurysm rebleeding and 12-month mortality. *Results:* During the study period, 263 (87.4%) patients were transferred to our institution and 38 (12.6%) were directly admitted for treatment of aneurysmal subarachnoid hemorrhage. Transfer time was not associated with the occurrence of symptomatic vasospasm, 12-month outcome, rebleeding, or 12-month mortality. Higher Hunt-Hess grade was associated with the occurrence of symptomatic vasospasm as well as with poorer 12-month outcome. *Conclusions:* Transfer time was not associated with the occurrence of symptomatic vasospasm, 12-month outcome, rebleeding, or 12-month mortality. We believe our data argue that protocols should emphasize early resuscitation and stabilization followed by safe transfer rather than a hyperacute transfer paradigm. However, transfer time should be minimized as much as possible so as not to delay time to definitive treatment. **Key Words:** Aneurysm—subarachnoid hemorrhage—vasospasm—transfer.

In the United States, more than 30,000 patients are admitted annually for the treatment of subarachnoid hemorrhage (SAH).[1] Over the past several decades, the incidence of SAH has remained relatively unchanged; however, there has been a sharp decline in the morbidity and mortality of patients admitted for treatment.[2] These improvements in morbidity and mortality are likely attributable to improved microsurgical and endovascular techniques, specialized neurological intensive care, and the optimization of care to avoid secondary brain injury after admission.[3,4]

One factor that has been considered in optimizing care for SAH patients is admission and treatment in low- versus high-volume hospitals. Rapid access to specialized treatment is among the important benefits that accompany treatment at a higher volume tertiary center.[5] Mounting evidence suggests that treatment at high-volume, tertiary/quaternary care centers improves outcomes and reduces mortality.[3,4,6] Currently, the American Heart Association and the American Stroke

From the *Department of Neurosurgery University of Michigan, Ann Arbor, Michigan; and †Bronson Methodist Hospital, Kalamazoo, Michigan.

Received August 27, 2014; revision received September 5, 2014; accepted September 9, 2014.

The authors have no financial disclosures.

Address correspondence to Thomas J. Wilson, MD, Department of Neurosurgery, University of Michigan, 1500 E. Medical Center Drive, Room 3552 TC, Ann Arbor, MI 48109-5338. E-mail: thowil@med.umich.edu.

[1] T.J.W. and Y.S. made equal contributions to this manuscript.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2014.09.009

Association recommend that low-volume hospitals consider transferring patients with SAH to higher volume centers with specialized services including endovascular surgery, microsurgical options, and neurointensive care services.[7] Although there are concerns about the inherent risks of transferring critically ill patients,[8] it has been shown that transferring SAH patients from lower volume institutions to specialty centers does not adversely affect outcome.[3]

At the present time, there is wide variance in transfer practices between institutions for reasons such as uncertainty about the optimal time frame for transfer and the absence of specific recommendations to guide the transfer process. Potential concerns regarding delayed transfer include rebleeding, higher risk of secondary brain injury from hemodynamic and respiratory compromise outside of the intensive care unit, and delayed implementation of neurosurgical care. The purpose of our study is to examine patients transferred and directly admitted to our institution to determine how transfer time and subarachnoid grade affect the occurrence of symptomatic vasospasm, functional outcome, and mortality of transferred patients as a group and in comparison to directly admitted patients. We hope that this study will offer valuable insight and guide transfer recommendations for SAH patients presenting at lower volume institutions.

Methods

Study Design

This cohort study was approved by the University of Michigan Institutional Review Board, and data were obtained by retrospective chart review. Information technology personnel designed and implemented a search paradigm to query information systems to identify all patients admitted who underwent microsurgical clip ligation or endovascular coil embolization of a cerebral circulation aneurysm after presenting with SAH between January 1, 2005, and February 1, 2012. This patient list was cross-referenced with the operative reports in the medical record to confirm that aneurysm treatment was performed and that initial presentation had been with a ruptured aneurysm.

Outcomes of Interest

The 2 primary outcomes of interest were functional outcome as assessed by Glasgow Outcome Scale (GOS) score at 12 months after presentation and the occurrence of symptomatic vasospasm. Poor outcome was defined as a GOS of 1-3. Symptomatic vasospasm was defined as a clinical neurologic change thought to be secondary to vasospasm where vasospasm was confirmed by angiography (either computed tomography angiography or conventional digital subtraction angiography) and in the absence of other causes such as rebleeding, hydrocephalus, electrolyte abnormalities, hypoxia, or seizures.

Secondary outcomes of interest included 12-month mortality and aneurysm rebleeding before treatment.

Referral Network

Our referral network includes a large geographic area covering portions of 3 states and includes urban, suburban, and rural hospitals. Geographically, the farthest referring hospitals are approximately 450 miles from our center. All transfers occurred either by ground transportation or helicopter.

Variables

Variables abstracted from the medical record and through review of radiographic studies included age, sex, occurrence of ventriculostomy placement, Hunt-Hess subarachnoid grade, posterior versus anterior circulation aneurysm (posterior communicating artery aneurysms were included as anterior circulation), treatment modality (microsurgical clip ligation versus endovascular coil embolization), aneurysm size, and transfer time. Transfer time was defined as the time between the first documented time at the outside institution to the first documented time at our institution. All ventriculostomies were placed at our institution; no patients were transferred with a ventriculostomy in place.

Statistical Analysis

Statistical analysis was performed using commercially available software (SPSS, version 18, IBM Corporation, Armonk, NY). Univariate comparison of continuous variables with a normal distribution was assessed using 2-sample *t*-tests, and continuous variables not meeting the normality assumption were assessed using the Mann-Whitney *U* test. All categorical data were assessed by chi-square test or Fisher exact test, as appropriate. Logistic regression was used to test univariate and multivariate associations between our variables of interest and the dichotomous outcome being assessed. We planned a priori to include all variables with $P < .20$ in univariate analysis and transfer time in our multivariate analyses. For all statistics, $P < .05$ was considered statistically significant.

Results

During the study period, 301 patients with aneurysmal SAH were treated at our institution. Of these, 263 (87.4%) were transferred to our institution and 38 (12.6%) were directly admitted. Table 1 shows demographic details for patients transferred and directly admitted. On average, patients who were transferred to our institution were older (54.7 versus 48.7 years), had a higher Hunt-Hess grade (2.65 versus 2.13), were more likely to require ventriculostomy placement (78.3% versus 65.8%), and