

## Endovascular Neurosurgery in the United States: A Survey of 59 Vascular Neurosurgeons with Endovascular Training

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■ **OBJECTIVE:** We sought to assess general aspects of endovascular neurosurgery training, practice, and management for the treatment of intracranial aneurysms, arteriovenous malformations, acute ischemic stroke, and extracranial or intracranial occlusive disease within neurosurgery training and practice in the United States.

■ **METHODS:** A questionnaire was sent electronically to 80 U.S. neurosurgeons with endovascular training.

■ **RESULTS:** Fifty-nine surveys (74%) were returned. Survey responses illustrated different practice patterns and varying management of cerebrovascular disorders by neurosurgeons with endovascular training.

■ **CONCLUSION:** Our findings provide a snapshot of current neurosurgical endovascular practices in the United States.

### Peer-Review Article

### INTRODUCTION

Following the efforts of a few pioneers in the late 1980s and early 1990s, endovascular neurosurgery has become an integral part of neurosurgery practice in the United States. Today many large neurosurgery practices have a vascular neurosurgeon on staff who has undergone endovascular training. In April 2009, we conducted a nationwide survey of endovascular neurosurgery practices to examine the training of endovascular neurosurgeons, identify practice patterns, and determine the management of the most common cerebrovascular diseases. Although surveys and polling questions cannot substitute for scientific research and are not necessarily a true reflection of actual

practices, they can provide perspective on the various practices and give insight on the interpretation and application of available evidence.

In this report, we summarize the answers to the survey questions to provide a contemporary snapshot of neurointervention in the United States as practiced by neurosurgeons. Answers are presented in a descriptive manner, and we use illustrative figures when appropriate.

### METHODS

An electronic survey containing questions about training, practice patterns, and management of various cerebrovascular diseases was prepared and sent to 80 vascular neurosurgeons with endovascular training throughout the United States. The addresses were obtained from an informally maintained list of vascular neurosurgeons with endovascular training across the United States. The invitation to participate in the survey was sent with a hyperlink from the research center of our institution. Reminders to nonresponders were sent 1, 2, and 3 weeks after the first mailing. One month after the first electronic mailing, the survey was closed and removed from the Internet. The survey was designed to be completed in approximately 20 minutes. Data were collected by the research center at our institution and analyzed in an anonymous manner. Fifty-nine surveys were completed for a total response rate of 74%.

### RESULTS

#### Demographics

Fifty-five percent of the responders were in academic practice, 38% in private practice, and the rest in government-run institutions (2%) or in various combinations of practice settings (5%).

#### Key words

- Arterial occlusive diseases
- Arteriovenous malformations
- Cerebrovascular disorders
- Endovascular neurosurgery
- Intracranial aneurysm

#### Abbreviations and Acronyms

**AVM:** arteriovenous malformation  
**MRA:** magnetic resonance angiography



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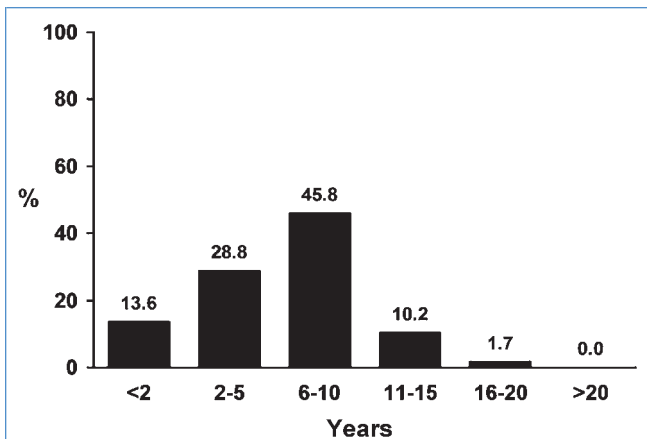
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**Figure 1.** Years in endovascular neurosurgery practice. Percentages total more than 100% because of rounding.

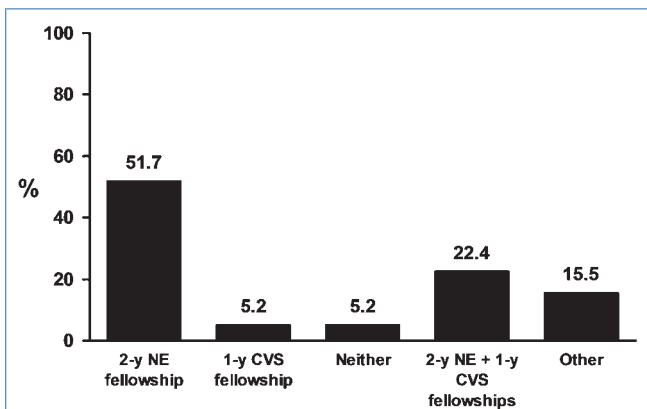
Almost 58% of participants had more than 5 years of experience in interventional practice (**Figure 1**).

**Training**

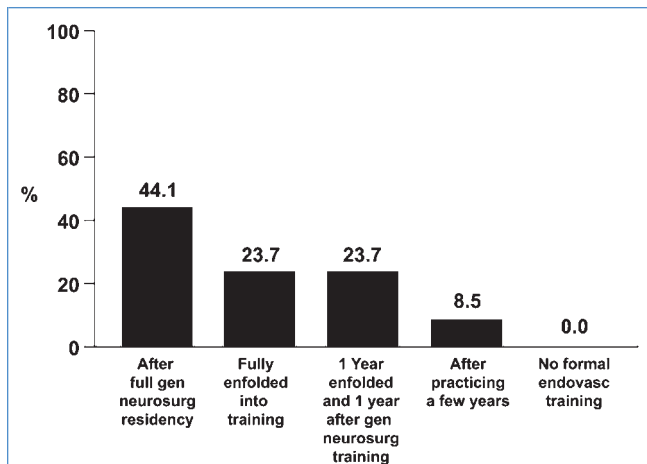
Most (74%) of the respondents had completed a two-year endovascular fellowship as their subspecialty training. Of these, 22% had also completed a one-year cerebrovascular surgery fellowship. A small percentage (5%) had completed a one-year open cerebrovascular neurosurgery fellowship without completing an endovascular fellowship. Various alternative patterns of training were reported by 15%. Although all the participants had received endovascular training, 10% had not completed a formal fellowship (**Figure 2**). The timing of the endovascular fellowship training in relation to the general neurosurgery training is shown in **Figure 3**. Forty-four percent of the respondents pursued endovascular training after completion of their neurosurgery residency.

**Practice Patterns and General Aspects**

The approximate number of diagnostic cerebral angiograms and neurointerventional procedures conducted annually at the participants' hospitals during the preceding 12 months are summa-



**Figure 2.** Subspecialty training of respondents. NE indicates neuroendovascular; CVS, cerebrovascular surgery.



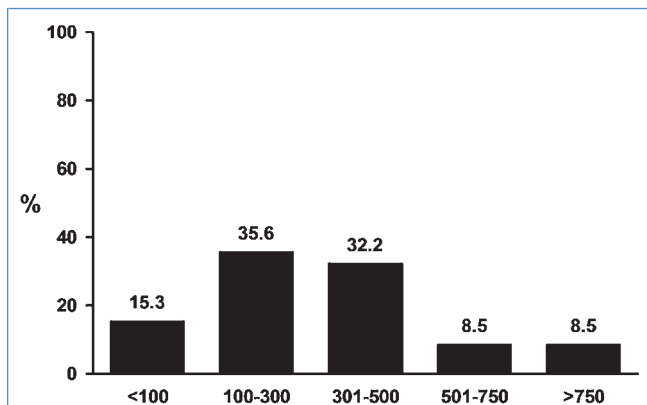
**Figure 3.** Timing of endovascular training in relation to open general neurosurgery training. Endovasc indicates endovascular; gen, general; neurosurg, neurosurgery.

riized in **Figures 4** and **5**, respectively. The neuroendovascular team at the respondents' institutions consisted of neurosurgeons only (41%); both neurosurgeons and neuroradiologists (44%); neurosurgeons, neuroradiologists, and neurologists (12%); or both neurosurgeons and neurologists (3%). Of the respondents' institutions, 46% offered a neurointerventional fellowship. With most referrals coming from neurosurgeons, they comprised the primary source (56%) of case referrals by clinical specialty (**Figure 6**).

Ninety-five percent of the survey respondents reported that they routinely performed open neurosurgical cases, whereas 5% concentrated their practice exclusively on endovascular procedures. The workload distribution of open neurosurgical to endovascular cases is shown in **Figures 7** and **8**.

**Intracranial Aneurysms**

Most (51%) respondents estimated that 51% to 75% of the aneurysms treated at their institutions in the 12 months preceding the survey were coiled rather than clipped (**Figure 9**). The percentage of modified coils used by the respondents is illustrated in **Figure 10**.



**Figure 4.** Number of diagnostic angiograms performed per year at the respondents' institutions. Percentages total more than 100% because of rounding.

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