Trends in Transcranial Doppler Monitoring in Aneurysmal Subarachnoid Hemorrhage: A 10-Year Analysis of the Nationwide Inpatient Sample

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Background: Transcranial Doppler (TCD) is endorsed by national guidelines for use in aneurysmal subarachnoid hemorrhage (aSAH) for surveillance of cerebral vasospasm (CV). However, nationwide data on utilization of TCD for CV detection and monitoring in aSAH are lacking. *Methods:* Analysis of nationwide trends in TCD prevalence was performed using Nationwide Inpatient Sample (NIS) data from 2002 to 2011. Raw counts were converted into weighted counts, which were used to generate national estimates. Teaching hospitals were examined separately for TCD utilization rates. All analyses accounted for the complex sampling design and sample discharge weights of the NIS, following Healthcare Cost and Utilization Project–NIS recommendations. The objective was to estimate the proportion of patients with aSAH receiving TCD monitoring using the NIS. *Results:* Between 2002 and 2011, a total of 256,089 patients were discharged with a diagnosis of aSAH, of which 3850 underwent TCD monitoring. aSAH accounted for an average of 67.1 discharges per 100,000 annually (95% confidence interval [CI] 61.3-72.8). Of these, 1.5% (95% CI 0.4-2.6) underwent TCD examination. In teaching hospitals, aSAH accounted for an average of 108.5 discharges per 100,000 biennially (95% CI, 96.2-120.8), of which 2% (95% CI 1.0-4.0) underwent TCD examination. TCD utilization increased from <1% during the 2002-2005 period to ≥1.5% during the 2006-2011 period (odds ratio 2.3, 95% CI 1.0-5.7), an increase also seen in teaching hospitals. *Conclusions:* TCD is underused nationally in the care of aSAH. Whereas the prevalence of TCD is low in teaching hospitals, it is nearly nonexistent in nonteaching hospitals. **Key Words:** Aneurysmal subarachnoid hemorrhage—transcranial Doppler—cerebral vasospasm—Nationwide Inpatient Sample.

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Introduction

Cerebral vasospasm (CV) is a dreaded complication of aneurysmal subarachnoid hemorrhage (aSAH), seen between 5 and 14 days following aSAH in up to 70% of patients angiographically and predicted by high mean flow velocities on transcranial Doppler (TCD).[1-4] In aSAH, CV is strongly associated with delayed cerebral ischemia, cerebral infarction, and death.[5-8] The use of TCD, a safe and effective modality for detection and monitoring of CV in aSAH, is endorsed by the American Heart Association/American Stroke Association, the American Academy of Neurology, and the Neurocritical Care Society.[9-11] However, it is unknown how effectively these guidelines translate into clinical practice. Moreover, although evidence and guidelines support the use of TCD in aSAH, TCD monitoring is still not mandatory in aSAH owing to lack of class I evidence demonstrating impact on clinically relevant outcomes such as functional independence and mortality.[12] Pragmatic patient-centered studies designed to evaluate comparative effectiveness of TCD monitoring have the potential to establish (or refute) the utility of this modality in patients with aSAH. However, before such a study can be designed, prevalence of use of TCD in aSAH needs to be established. Thus, we sought to investigate the prevalence of TCD use in patients with aSAH over a 10-year period using the Nationwide Inpatient Sample (NIS). The NIS contains discharge data both at the patient level and at the hospital level from states that participate in the Healthcare Cost and Utilization Project (HCUP). Comprising data from approximately 1000 US hospitals annually, the NIS is designed as a stratified 20% representative sample of all nongovernment hospitals nationwide.

Methods

Data Source

We analyzed data from the NIS, for the years 2002-2011. The NIS is a national database of in-patient discharges maintained as part of the HCUP by the Agency for Healthcare Research and Quality. The NIS represents a probability sample of nonfederal US community-based in-patient healthcare facilities and, through the use of design variables included in the dataset, can provide weighted national estimates. Released annually, the database includes comprehensive information on in-patient discharges, including diagnoses and procedures (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes), as well as hospital characteristics. More information on NIS is available at http://www.hcup-us.ahrq.gov/nisoverview.jsp.

Inclusion and Exclusion Criteria

Discharges were coded as aSAH if the primary discharge diagnosis was ICD-9-CM 430. Discharges were excluded if head trauma (ICD-9-CM 800.0-801.9, 803.0-804.9, 850.0-854.1, 873.0-873.9) or arteriovenous malformation or fistula (ICD-9-CM diagnosis 747.81; ICD-9-CM procedures 39.53, 92.30) was among the top 15 diagnoses. Observations were also excluded if the patient's length of stay was less than 1 day, with an associated discharge to home. This was done to exclude the superficial cortical and non-aneurysmal SAH cases. Discharges receiving TCD at any time during hospitalization were identified using ICD-9-CM procedure code 88.71 (diagnostic ultrasound of the head and neck).

Analysis

We used the complex sample module, SPSS Statistics 23 (Armonk, NY: IBM Corp), to convert raw counts into weighted national estimates. All analyses accounted for the complex sampling design and sample discharge weights of the NIS following HCUP–NIS recommendations. The number of patients with aSAH per 100,000 discharges and the proportion of patients with aSAH who received TCD were estimated for each year and overall. Estimates were also stratified by teaching hospital status, and TCD utilization rates for teaching hospitals were calculated biennially to prevent small numbers.

Results

Between 2002 and 2011, a total of 382,104,673 discharges were observed, with 256,089 (95% confidence interval [CI 234,049-278,129) discharges having a primary diagnosis of aSAH. TCD was performed on 3850 patients (95% CI 1093-6606), representing 1.5% of aSAH discharges. Tables 1-3 illustrate the annual number of patients with aSAH per 100,000 discharges and the proportion undergoing TCD examination. TCD utilization increased from <1% during the 2002-2005 period to ≥1.5% during the 2006-2011 period (odds ratio 2.3, 95% CI 1.0-5.7), an increase also seen in teaching hospitals (Figs 1, 2). For the 2002-2011 period, the proportion of aSAH discharges receiving TCD was substantially higher at teaching hospitals than at nonteaching hospitals (2.0% versus 0.2%; odds ratio 8.4, 95% CI 3.2-21.7), with 96.0% of all TCDs performed at teaching hospitals.

Discussion

Using the NIS, we found that only 1.5% of aSAH discharges received TCD monitoring. This is the first evidence that the use of TCD monitoring for CV detection in aSAH is low, despite endorsement by national guidelines. Moreover, we observed that the majority of TCD examinations were performed at teaching hospitals. This may be the result of more severe aSAH being managed at teaching hospitals and tertiary care centers compared with nonteaching hospitals.[13] A survey of Neurocritical Care Society members revealed that 88.6% of patients were