Statewide Trends in Utilization and Outcomes of Endovascular Treatment of Acute Ischemic Stroke: Analysis of Minnesota Hospital Association Data (2014 and 2015)

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Background: The study aims at examining the changes in endovascular procedures utilization after the publication of the clinical trials showing their benefit in patients with acute ischemic stroke (AIS). *Methods:* Minnesota Hospital Association database from 137 member hospitals was used to calculate the statewide utilization rates for 2 periods: prior to (calendar year 2014) and after (calendar year 2015) the publication of multiple randomized clinical trials showing the efficacy of endovascular therapy. Patients were identified using International Classification of Disease, Clinical Modification, 9th revision (ICD-9) or ICD-10 codes (ICD-10 started October 2015). Utilization rates for endovascular treatment were calculated monthly, quarterly, and annually. *Results:* Of the 13,043 patients admitted with AIS, 434 patients (mean age 68.5 ± 15.5 years; 51.2% women) received endovascular treatment. The number of procedures increased from 194 in 2014 to 240 in 2015. Utilization rate was 3.4% in the first quarter of 2014, gradually declined to reach its lowest value (2.6%) the last quarter of 2014, then steadily increased to reach its peak (4%) in the last quarter of 2015. Procedures performed at comprehensive stroke centers increased from 52% of total procedures in 2014 to 57.5% in 2015, whereas those performed at primary stroke centers decreased from 22.6% to 19.5%. In 2015, fewer patients had hypertension (50.4% versus 60.3%; $P = .039$) and more patients had chronic kidney disease (28.3% versus 15.5%; $P = .001$) compared with 2014. Intracranial hemorrhage, mortality rate, and rate of home discharge were similar between the 2 years. *Conclusion:* Utilization of endovascular procedures for treatment of AIS has been rapidly influenced by medical literature. **Key Words:** Endovascular treatment—intra-arterial treatment for stroke—Minnesota Hospital Association—clinical trials—endovascular utilization.

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Received June 16, 2017; revision received September 11, 2017; accepted September 27, 2017.

Grant support: This study did not receive any grant support.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2017.09.056

Introduction

In 2013, 3 randomized clinical trials published showing the lack of benefit of endovascular treatment for acute ischemic stroke.[1-3] This came as a surprise to the stroke research world, most of which was under the impression that endovascular intervention is beneficial based on case series, anecdotal reports, and 1 randomized trial 14 years earlier.[4] However, before the end of the following year, 2014, the first, large randomized endovascular trial reported benefit of the intervention.[5] Four ongoing trials were paused and available data were analyzed. All

4 showed endovascular treatment benefit, and were subsequently terminated for lack of equipoise.[6-9] In June 2015, the American Heart Association/American Stroke Association published an addendum to the guidelines for acute ischemic stroke treatment recognizing endovascular intervention as a potential treatment for patients with large vessel occlusion.[10]

This relatively fast shift of evidence from lack of evidence to strong favorable evidence provides a unique opportunity to study the impact of clinical research on clinical practice. The aim of this study is to follow the trend of endovascular utilization in acute stroke in the state of Minnesota during the years 2014 and 2015 and the impact of the recent positive clinical trials.

Methods

Data Source

We used the Minnesota Hospital Association (MHA) database in this study. The MHA is a nonprofit organization that collects quality and administrative data from its 137 hospitals and health systems providing health care throughout the state of Minnesota.[11]

This analysis was performed on the data of hospital discharges between January 1, 2014 and December 31, 2015. This particular time frame was chosen to represent 2 periods: prior to (January 1 to December 31, 2014) and after (January 1 to December 31, 2015) publication of randomized clinical trials. Because it was the secondary analysis of existing de-identified data, our study did not require approval from institutional review board.

Study Sample

The study sample was the patients who were admitted with ischemic stroke and received endovascular treatment in the time frame above. We identified patients with primary diagnosis of ischemic stroke using International Classification of Diseases, Clinical Modification, 9th revision (ICD-9 CM) primary diagnosis codes (433-437.1), as used in previous studies.[12] In October 2015, the coding system was changed to ICD-10.

Study Data

We identified patients with primary diagnosis of acute ischemic stroke with ICD-9 codes 433-437.1 and ICD-10 codes: G45.0-G46.8, 163.011-163.119, 136.211-163.219, 163.30-163.49, 163.50-163.9, 165.01-165.09, 166.01-166.9, 167.2, and 167.4 -168.8.

Patients who received endovascular treatment were identified using the ICD-9 procedure code 39.74, the combination of codes 99.10 and 00.41-00.43, and ICD-10 codes 03CG3ZZ, 03CH3ZZ, 03CJ3ZZ, 03CK3ZZ, 03CL3ZZ, 03CP3ZZ, and 03CQ3ZZ. For the study population, we extracted the demographic data (age and gender), administration of intravenous thrombolysis (IVT; ICD-9 CM code 99.10 and ICD-10 code 3E03317), and comorbid conditions, including hypertension, diabetes mellitus, congestive heart failure, atrial fibrillation, renal failure and tobacco abuse using the relevant ICD-9 CM and ICD-10 codes.

In-hospital medical complications were identified as follows: intracranial hemorrhage (ICD-9-CM 430, 431, and 432; ICD-10 I60-62) acquired pneumonia (ICD-9-CM 486, 481, 482.8, and 482.3 and ICD-10 J69.0, J95.851, and J13-18), urinary tract infection (ICD-9-CM 599.0 and 590.9; ICD-10 N39.0), sepsis (ICD-9-CM 995.91, 996.64, 038, 995.92, and 999.3; ICD-10 A41), deep venous thrombosis (451.1, 451.2, 451.81, 451.9, 453.1, 453.2, 453.8, and 453.9; ICD-10 I82), pulmonary embolism (ICD-9-CM 415.1; ICD 10 I26), respiratory failure (ICD-9 code 518.81; ICD10 J96), and myocardial infarction (ICD-9-CM 410; ICD-10 I21).

We also examined the following outcome data: length of stay, discharge destination (discharge to home, rehabilitation facility, nursing home, etc.), in-hospital mortality, and total hospital charges. Patients who were discharged home were considered to have no to minimal disability.

Statistical Analysis

Using SPSS Version 20 (IBM Corp, Armonk, NY), we performed descriptive analysis of the whole study sample. The rate of endovascular utilization was calculated as the percentage of patients with acute ischemic stroke who received endovascular treatment. We examined the utilization trend in the primary (n = 18) and comprehensive (n = 6) stroke centers. The sample was dichotomized by calendar year, 2014 versus 2015. Univariate analysis was performed to compare demographic characteristics, comorbidities, in-hospital complications and mortality, length of stay, discharge destination, and hospital charges. Nominal variables were compared with chi-square, continuous variables with *t*-test, and nonparametric variables with Wilcoxon rank-sum test. Statistical significance was defined as $P \leq .05$.

Results

Between January 1, 2014 and December 31, 2015, 13,043 patients were admitted with the primary diagnosis of acute ischemic stroke. Of those, 434 patients received endovascular treatment (3.3%; mean age 68.5 ± 15.5 years; 51.2% women): 194 patients in 2014 and 240 patients in 2015. Utilization rate was 3.4% in the first quarter of 2014, gradually declined to reach its lowest value (2.6%) the last quarter of 2014, then steadily increased to its peak (4%) in the last quarter of 2015. In the same time period, 816 patients received IVT (6.3%). The rate of utilization remained unchanged throughout the study period (Fig 1). The median length of stay, 5 days, did not change from 2014 to 2015 and was statistically longer than those who did not have endovascular therapy ($P < .001$; Supplementary Figure S1). Overall hospital charges increased from 2014