National Trends in Utilization and Outcomes of Endovascular Treatment in Acute Ischemic Stroke Patients in Pre- and Post-Stent Retriever Era in United States

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BACKGROUND
Several new studies have shown improved outcomes in ischemic stroke patients treated with mechanical thrombectomy in clinical trials setting after introduction of stent retrievers.

The outcomes of patients undergoing endovascular treatment in general practice are expected to improve.

METHODS
We obtained data for patients admitted with primary diagnosis of ischemic stroke in United States from 2009 to 2016 using Nationwide Inpatient Sample.

We determined the rate and pattern of utilization, and associated in-hospital outcomes of endovascular treatment among ischemic stroke patients.

Outcomes were classified as minimal disability, moderate to severe disability, and death based on discharge disposition and compared between two time periods: 2009-2011 and 2013-2016 to represent pre and post stent retriever approvals in United States.

<table>
<thead>
<tr>
<th>Year</th>
<th>Utilization % (95% CI)</th>
<th>OR (95% CI)</th>
<th>Minimal disability</th>
<th>OR (95% CI)</th>
<th>In-Hospital Mortality</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>0.55 (0.50 - 0.60)</td>
<td>1 (Reference)</td>
<td>1.30 (0.92 - 1.83)</td>
<td>1 (Reference)</td>
<td>1.00 (0.74 - 1.37)</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>0.75 (0.70 - 0.81)</td>
<td>1.37 (1.22 - 1.55)</td>
<td>1.03 (0.73 - 1.45)</td>
<td>0.87 (0.65 - 1.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>0.78 (0.73 - 0.84)</td>
<td>1.42 (1.27 - 1.60)</td>
<td>1.63 (1.19 - 2.23)</td>
<td>0.70 (0.52 - 0.94)</td>
<td>0.71 (0.53 - 0.96)</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>1.08 (1.02 - 1.15)</td>
<td>1.98 (1.77 - 2.21)</td>
<td>1.56 (1.14 - 2.12)</td>
<td>0.63 (0.47 - 0.85)</td>
<td>0.65 (0.49 - 0.85)</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>1.22 (1.15 - 1.29)</td>
<td>2.23 (2.00 - 2.49)</td>
<td>1.95 (1.45 - 2.65)</td>
<td>0.59 (0.45 - 0.78)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>1.36 (1.28 - 1.43)</td>
<td>2.48 (2.23 - 2.76)</td>
<td>2.26 (1.69 - 3.01)</td>
<td>0.59 (0.45 - 0.78)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>1.99 (1.91 - 2.08)</td>
<td>3.67 (3.32 - 4.06)</td>
<td>2.14 (1.61 - 2.85)</td>
<td>0.59 (0.45 - 0.78)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>2.03 (1.95 - 2.11)</td>
<td>3.74 (3.38 - 4.14)</td>
<td>2.14 (1.61 - 2.85)</td>
<td>0.59 (0.45 - 0.78)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There was a fourfold increase in patients who underwent endovascular treatment (0.55% of ischemic strokes in 2009 vs. 2.03% in 2016, trend p < 0.001).

In multivariate logistic regression analysis, the rate of none to minimal disability improved between the two study intervals (2009-2011 versus 2013-2016), odds ratio (OR) 1.82, 95% confidence interval (CI) 1.47-2.67, p=<0.0001 and moderate to severe disability decreased (OR 0.56, 95% CI 0.45-0.70, p = <0.0001).

There was significant decrease inpatient mortality for patients treated during 2013-2016; OR 0.67, 95% CI 0.56-0.79, p = <0.0001).

CONCLUSION
Our analysis support generalizability of the successful results observed in clinical trials of endovascular treatment in acute ischemic stroke patients in post-stent retriever approval era in United States.

Ischemic Stroke Patients Treated with Endovascular Treatment

<table>
<thead>
<tr>
<th>Study period</th>
<th>2009-2011</th>
<th>Study period</th>
<th>2013-2016</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Number</td>
<td>35164</td>
<td>35164</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (95% CI)</td>
<td>66.2 (65.3-67.0)</td>
<td>68.0 (67.6-67.6)</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>% Female</td>
<td>49.7</td>
<td>49.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbid Conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>71.9</td>
<td>72.5</td>
<td>0.6505</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>20.9</td>
<td>26.4</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>CHF</td>
<td>17.3</td>
<td>21.3</td>
<td>0.0004</td>
<td></td>
</tr>
<tr>
<td>Renal failure</td>
<td>7.8</td>
<td>10.7</td>
<td>0.0004</td>
<td></td>
</tr>
<tr>
<td>Hospital Location and Teaching Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>0.6</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban nonspecialist</td>
<td>17.7</td>
<td>11.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban teaching</td>
<td>81.8</td>
<td>88.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Medical complications and hospital procedures

<table>
<thead>
<tr>
<th>Outcome</th>
<th>2009-2011</th>
<th>2013-2016</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>18.6</td>
<td>21.3</td>
<td>0.0766</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>7.0</td>
<td>8.6</td>
<td>0.0514</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>18.1</td>
<td>13.8</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sepsis</td>
<td>2.7</td>
<td>4.3</td>
<td>0.0005</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1.4</td>
<td>1.6</td>
<td>0.8406</td>
</tr>
<tr>
<td>Deep venous thrombosis</td>
<td>1.6</td>
<td>2.6</td>
<td>0.1099</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>28.3</td>
<td>20.5</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

Discharge Status

<table>
<thead>
<tr>
<th>Outcome</th>
<th>2009-2011</th>
<th>2013-2016</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Died in hospital</td>
<td>20.5</td>
<td>14.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Minimal disability</td>
<td>21.0</td>
<td>30.9</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Moderate to severe disability</td>
<td>78.5</td>
<td>65.9</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>