Cost-Effectiveness of Solitaire + IV t-PA for Acute Ischemic Stroke: Results from the SWIFT PRIME Trial

Theresa I. Shireman, PhD
on behalf of the SWIFT PRIME Investigators

Saint Luke’s Mid America Heart Institute and Brown University School of Public Health
Disclosures

• National MS Society, National Institutes of Health, Patient-Center Outcomes Research Institute

• SWIFT PRIME Trial including the economic substudy funded by Medtronic

• The data reported here have been supplied by the Centers for Medicare & Medicaid Services (DUA#27848). The interpretation and reporting of these data are the responsibility of the author(s) and in no way should be seen as an official policy or interpretation of the U.S. government.
Background

- Results from SWIFT PRIME trial\(^1\)
  - Reduced post-stroke disability as measured by mRS
  - Greater proportion of patients alive and independent at 90 days

- Prior cost-effectiveness studies of mechanical thrombectomy have important limitations\(^2,3\)
  - Costs of therapy based on assumptions rather than empirical data
  - Long-term costs, survival, and utilities from historical data (> 20 years old)

---

\(^1\) Saver, NEJM 2015;372:2285-95
\(^2\) Ganesalingam, Stroke 2015;46(9):291-8
\(^3\) Leppert, Stroke 2015; 46(7):1870-6
Economic Study: Objectives

➢ To assess the lifetime, incremental cost-effectiveness of the Solitaire stent retriever + IV t-PA vs. IV t-PA alone in treating patients with acute ischemic stroke

➢ Trial-based, person-level analysis

➢ US healthcare system perspective

➢ Cost per quality-adjusted life year (QALY) gained
Index Hospitalization

- Procedural
  - Interventionist & anesthesiologist
  - Devices & contrast
  - Non-physician care
  - Room overhead

- Non-procedural
  - Hospital days
  - Imaging
  - Inpatient physician

Post-discharge to 90 days

- Hospitalizations
- Physician visits
- Emergency room visits
- Skilled nursing facility days
- Rehabilitation visits/days
- Home health visits
- Utility: Euro-QoL (EQ-5D)

Methods: Trial Resource Use & Utility

Post-discharge to 90 days

- Hospitalizations
- Physician visits
- Emergency room visits
- Skilled nursing facility days
- Rehabilitation visits/days
- Home health visits
- Utility: Euro-QoL (EQ-5D)
Methods: Post-Trial Resources & Survival

- Nursing facility residence
  - Disposition at end of 90-day follow-up

- Hospitalization and rehabilitation*
  - Medicare claims

- Life expectancy*
  - National Death Index
  - Annual mortality from US life tables\(^1\) for mRS 0-1
  - Relative risk of mortality for mRS > 1 based on Cox model

\(^*\) External cohort
958 acute ischemic stroke patients from two stroke centers with 90-day mRS

\(^1\)National Vital Statistics Report, Centers for Disease Control and Prevention, 2014
Methods: Cost Valuation

- **US healthcare system perspective**
  - Procedural: unit costs from three US study hospitals
  - Non-procedural:
    - Medicare cost-to-charge ratios applied to hospital bills
    - Non-US hospital: event based modeling
  - Post-discharge (90-day and long-term)
    - Medicare fee schedule
    - Medicaid daily rates for post-90 day nursing home care

- 2015 US dollars

- 3% discount rate (base case)
## SWIFT PRIME: Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Solitaire + IV t-PA (N = 98)</th>
<th>IV t-PA (N=92)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age – years, Mean (SD)</td>
<td>65.0 ±12.5</td>
<td>65.8 ±11.2</td>
<td>0.62</td>
</tr>
<tr>
<td>Male – (%)</td>
<td>55.1%</td>
<td>46.7%</td>
<td>0.31</td>
</tr>
<tr>
<td>Prestroke mRS – (%)</td>
<td></td>
<td></td>
<td>0.88</td>
</tr>
<tr>
<td>0</td>
<td>82.7%</td>
<td>82.6%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>15.3%</td>
<td>16.3%</td>
<td></td>
</tr>
<tr>
<td>≥2</td>
<td>2.0%</td>
<td>1.1%</td>
<td></td>
</tr>
<tr>
<td>NIHSS Score – Median</td>
<td>17.0</td>
<td>17.0</td>
<td>0.86</td>
</tr>
<tr>
<td>IV t-PA at outside hospital – (%)</td>
<td>31.6%</td>
<td>35.9%</td>
<td>0.54</td>
</tr>
<tr>
<td>Time from stroke onset to randomization – min, Median</td>
<td>190.5</td>
<td>185.0</td>
<td>0.69</td>
</tr>
</tbody>
</table>
Index Hospitalization Costs

Δ = $17,183 (p<0.001)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Non-procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solitaire + IV t-PA</td>
<td>$14,669</td>
</tr>
<tr>
<td>IV t-PA</td>
<td>$28,578</td>
</tr>
</tbody>
</table>
# Post-Discharge to 90-day Resource Utilization

<table>
<thead>
<tr>
<th>Utilization per 100 patients</th>
<th>Solitaire + IV t-PA</th>
<th>IV t-PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-hosp days</td>
<td>22.4</td>
<td>21.7</td>
</tr>
<tr>
<td>IP Rehab/SNF days</td>
<td>2,688</td>
<td>3,629</td>
</tr>
<tr>
<td>Outpatient rehab visits</td>
<td>352</td>
<td>681</td>
</tr>
<tr>
<td>ER visits</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Physician visits</td>
<td>166</td>
<td>204</td>
</tr>
</tbody>
</table>
Post-Discharge to 90-day Costs

$\Delta = -\$4,904 \text{ (p=0.003)}$

$\begin{align*}
\text{Solitaire + IV t-PA} & : \$11,270 \\
\text{IV t-PA} & : \$16,174
\end{align*}$
Index through 90-day Costs

Δ = $12,279 (p<0.001)

Solitaire + IV t-PA: $57,031
IV t-PA: $44,752
Quality of Life: Utility Weights

- Solitaire + IV t-PA
- IV t-PA

Days post-stroke

-30 0 30 60 90 120

0.158 0.153 0.518 0.662 0.712 0.611

P = 0.004 P = 0.019
Projected Survival: Lifetime

Undiscounted LYs

Solitaire + IV t-PA = 11.76 years
IV t-PA = 10.02 years
\( \Delta = 1.74 \) years

Years since randomization
## Cost-Effectiveness: Base Case Results

<table>
<thead>
<tr>
<th></th>
<th>Solitaire + IV t-PA</th>
<th>IV t-PA</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>$ 215,781</td>
<td>$ 238,984</td>
<td>-$23,203</td>
</tr>
<tr>
<td>QALYs</td>
<td>6.789</td>
<td>5.046</td>
<td>1.74</td>
</tr>
</tbody>
</table>
Lifetime Cost-Effectiveness: Base Case

Δ Cost (Solitaire + IV t-PA)

$100,000

$50,000

$0

-$50,000

-$100,000

Δ QALY

$50,000 per QALY

Δ Cost = - $23,203
Δ QALY = 1.74
Solitaire economically dominant

Δ Cost (Solitaire + IV t-PA)

$100,000

$50,000

$0

-$50,000

-$100,000

Δ QALY

$50,000 per QALY

Δ Cost = - $23,203
Δ QALY = 1.74
Solitaire economically dominant
### Subgroup Analyses

<table>
<thead>
<tr>
<th></th>
<th>Solitaire Cost ($)</th>
<th>IV t-PA Cost ($)</th>
<th>Solitaire QALYs</th>
<th>IV t-PA QALYs</th>
<th>ICER ($/QALY)</th>
<th>% Dominant</th>
<th>% &lt; $50K</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 65 years</td>
<td>279,861</td>
<td>326,109</td>
<td>9.81</td>
<td>8.23</td>
<td>Dominant</td>
<td>88.4%</td>
<td>95.8%</td>
</tr>
<tr>
<td>65-75 years</td>
<td>187,038</td>
<td>231,731</td>
<td>5.47</td>
<td>3.89</td>
<td>Dominant</td>
<td>94.7%</td>
<td>98.9%</td>
</tr>
<tr>
<td>&gt; 75 years</td>
<td>133,155</td>
<td>105,200</td>
<td>3.32</td>
<td>2.09</td>
<td>22,801</td>
<td>5.7%</td>
<td>82.2%</td>
</tr>
<tr>
<td><strong>By geographic location</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td>233,544</td>
<td>243,585</td>
<td>6.86</td>
<td>5.25</td>
<td>Dominant</td>
<td>66.6%</td>
<td>97.6%</td>
</tr>
<tr>
<td>OUS</td>
<td>183,314</td>
<td>229,335</td>
<td>6.57</td>
<td>4.63</td>
<td>Dominant</td>
<td>94.9%</td>
<td>99.5%</td>
</tr>
<tr>
<td><strong>By time to randomization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 189 minutes</td>
<td>224,541</td>
<td>260,311</td>
<td>6.65</td>
<td>5.04</td>
<td>Dominant</td>
<td>89.1%</td>
<td>97.5%</td>
</tr>
<tr>
<td>≤ 189 minutes</td>
<td>207,117</td>
<td>220,280</td>
<td>6.91</td>
<td>5.04</td>
<td>Dominant</td>
<td>71.5%</td>
<td>98.7%</td>
</tr>
</tbody>
</table>
Time to Break Even

Years since randomization vs. Total costs

- Solitaire + IV t-PA
- IV t-PA

~21.5 months
Summary

Mechanical thrombectomy using Solitaire stent retriever + IV t-PA compared to IV t-PA alone:

- Higher index hospital costs ($14,669)
- Lower post-discharge to 90 day costs ($4,904)
- Cost savings over a lifetime horizon ($23,203/patient)
- Substantial gains in quality-adjusted life expectancy (1.74 QALYs)
- Economic dominance was consistent across…
  - Key sensitivity analyses
  - Broad range of patient subgroups
Limitations

- Long-term survival modeled from 4-year observation of external cohort
- Assumed no further improvement in health status beyond 90 days
Conclusions

Solitaire stent retriever + IV t-PA vs IV t-PA alone:

- Highly cost-effective
- Economically dominant
- Costs less
- Better outcomes
Acknowledgements

Saint Luke’s Hospital Mid-America Heart Institute (Kansas City)

• Dr. David Cohen
• Dr. Kaijun Wang
• Katherine Vilain

Washington University School of Medicine

• Dr. Jin-Moo Lee
### US Enrolling Centers

<table>
<thead>
<tr>
<th>Number</th>
<th>Location / Institution</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>UCLA / Ronald Reagan UCLA Medical Center</td>
<td>Starkman</td>
</tr>
<tr>
<td>102</td>
<td>Oregon Health and Science University (OHSU)</td>
<td>Clark</td>
</tr>
<tr>
<td>103</td>
<td>University of Pittsburgh Medical Center</td>
<td>Reddy</td>
</tr>
<tr>
<td></td>
<td>University of Buffalo Neurosurgery /</td>
<td>Siddiqui</td>
</tr>
<tr>
<td>104</td>
<td>Buffalo General Hospital</td>
<td>Yavagal</td>
</tr>
<tr>
<td>105</td>
<td>University of Miami / Jackson Memorial Hospital</td>
<td>Devlin</td>
</tr>
<tr>
<td></td>
<td>Chattanooga Center for Neurologic Research /</td>
<td>Jagadeesan</td>
</tr>
<tr>
<td>106</td>
<td>Erlanger Hospital</td>
<td>Fitzsimons</td>
</tr>
<tr>
<td>109</td>
<td>Hennepin County Medical Center</td>
<td>Ecker</td>
</tr>
<tr>
<td>110</td>
<td>Medical College of Wisconsin / Froedtert Hospital West</td>
<td>Budzik</td>
</tr>
<tr>
<td>111</td>
<td>Maine Medical Center</td>
<td>Acosta</td>
</tr>
<tr>
<td>113</td>
<td>Hospital</td>
<td>Deshaies</td>
</tr>
<tr>
<td>116</td>
<td>Florida Hospital</td>
<td>Jumaa</td>
</tr>
<tr>
<td>117</td>
<td>SUNY Upstate Medical University</td>
<td>Ramsey</td>
</tr>
<tr>
<td>118</td>
<td>ProMedica Toledo Hospital</td>
<td>Ramsey</td>
</tr>
<tr>
<td>120</td>
<td>Central Baptist</td>
<td>Hussain</td>
</tr>
<tr>
<td>121</td>
<td>Cleveland Clinic</td>
<td>Carpenter</td>
</tr>
<tr>
<td>122</td>
<td>West Virginia University</td>
<td>Deshmukh</td>
</tr>
<tr>
<td>123</td>
<td>Providence Brain and Spine Institute</td>
<td>Puri</td>
</tr>
<tr>
<td>124</td>
<td>University of Massachusetts Medical Center</td>
<td>Nogueira</td>
</tr>
<tr>
<td>125</td>
<td>Emory University / Grady Medical Center</td>
<td>Lopes</td>
</tr>
<tr>
<td>126</td>
<td>Rush University Medical Center</td>
<td>Martin</td>
</tr>
<tr>
<td>129</td>
<td>Saint Luke’s Hospital of Kansas City</td>
<td>Farid</td>
</tr>
<tr>
<td>130</td>
<td>St. Jude Medical Center</td>
<td>Hassan</td>
</tr>
<tr>
<td>134</td>
<td>Valley Baptist Medical Center</td>
<td>Malek</td>
</tr>
<tr>
<td>135</td>
<td>Tenet Hospital System</td>
<td></td>
</tr>
</tbody>
</table>

### EU Enrolling Centers

<table>
<thead>
<tr>
<th>Number</th>
<th>Location / Institution</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>CHU Montpellier - Hôpital Gui de Chauliac</td>
<td>Bonafé</td>
</tr>
<tr>
<td>203</td>
<td>Universitätssklinikum Kiel</td>
<td>Jansen</td>
</tr>
<tr>
<td>204</td>
<td>Hospital Clinico Universitario de Valladolid</td>
<td>Arenillas</td>
</tr>
<tr>
<td>206</td>
<td>Klinikum der Johann Wolfgang Goethe-Universität – Frankfurt</td>
<td>du Mesnil de Rochemont</td>
</tr>
<tr>
<td>207</td>
<td>Kantonsspital Aarau</td>
<td>Remonda</td>
</tr>
<tr>
<td>212</td>
<td>Universitätssklinikum Essen</td>
<td>Weimar</td>
</tr>
<tr>
<td>213</td>
<td>Rigshospitalet – Copenhagen</td>
<td>Hansen</td>
</tr>
<tr>
<td>214</td>
<td>Klinikum Bremen-Mitte</td>
<td>Papanagiotou</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Killer-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oberpfalzer</td>
</tr>
<tr>
<td>216</td>
<td>Universitätssklinikum Christian Doppler Klinik Salzburg</td>
<td>Ringleb</td>
</tr>
<tr>
<td>218</td>
<td>Universitätssklinikum Heidelberg</td>
<td>Reimann</td>
</tr>
<tr>
<td>220</td>
<td>Klinikum Dortmund</td>
<td>Brekenfeld</td>
</tr>
<tr>
<td>224</td>
<td>Universitaetsklinikum Hamburg-Eppendorf</td>
<td>Prothmann</td>
</tr>
<tr>
<td>225</td>
<td>Klinikum rechts der Isar der TU Munchen</td>
<td>Haring</td>
</tr>
<tr>
<td>228</td>
<td>Landes - Nervenklinik Wagner-Jauregg</td>
<td>Andersen</td>
</tr>
<tr>
<td>229</td>
<td>Aarhus University Hospital</td>
<td></td>
</tr>
</tbody>
</table>