TENNESSEE STROKE REGISTRY REPORT, 2015

A partnership between East Tennessee State University College of Public Health, the Tennessee Department of Health and the American Heart/American Stroke Association.
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Executive Summary

In 2008, the Tennessee General Assembly passed a bill requiring East Tennessee State University’s College of Public Health to maintain a statewide stroke database and requesting hospitals to report data on stroke quality metrics beginning in 2009. Currently, twelve hospitals are enrolled in the Tennessee Stroke Registry (TSR) and data from only those hospitals are included in this report. Based on those data, ischemic strokes accounted for approximately 78.5% of all strokes in Tennessee in 2015. There is an equal distribution of males and females who had a stroke, however, gender distribution varies with stroke subtypes. For instance, the data reported suggest that 63% of subarachnoid hemorrhage patients are female. Patients over the age of 66 make up approximately 56% of stroke patients, but again, this distribution varies with subtype. Patients of subarachnoid hemorrhages tend to be younger with an average age of 58.2 years compared to the overall average age of 67.1 years for all strokes. As supported by many other studies, these data also show that hypertension is the most common co-morbidity of stroke and is therefore an important stroke risk factor to control. Arrival mode (EMS, private transport, or transfer from another hospital) is approximately evenly distributed among all stroke types, but shows a much higher percentage (55%) of TIA patients arriving to the hospitals by means of private transportation. A greater percentage of stroke patients who traveled to the hospital via EMS rather than private transportation, arrived in less than 3 hours, emphasizing the importance of seeking prompt medical assistance in the case of a stroke. Of all stroke cases reported to the TSR, 61.7% of patients had Medicare insurance. Increasing reporting to the TSR would strengthen the quality of the data and produce a more comprehensive report.
Introduction to the Tennessee Stroke Registry

The Tennessee Stroke Registry was established in 2008 through a bill enacted by the 105th General Assembly of the State of Tennessee. The Stroke Registry Act of 2008* calls for East Tennessee State University’s College of Public Health to maintain a statewide stroke database and report statistics on stroke prevalence, mortality, and performance metrics based on American Heart Association’s Get With the Guidelines standards beginning in 2009. The report is compiled with data input by Tennessee hospitals into Get With the Guidelines, American Heart’s suite of quality improvement registry programs, and is released on an annual basis. Participation in the stroke registry is voluntary and helps to gain a comprehensive picture of stroke in Tennessee. The purpose of the registry is to shed light on the impact and burden of stroke in Tennessee.

*Public Chapter No. 1186/Senate Bill No. 4011 of the 105th General Assembly of the State of Tennessee
Overview of Stroke

A cerebrovascular accident, often referred to as a “stroke,” occurs when blood flow to the brain is interrupted, depriving brain tissue of oxygen and nutrients. This interruption can be the result of either the blockage (ischemic) or rupture (hemorrhagic) of a blood vessel supplying blood to the brain.\textsuperscript{1,2}

In 2013, stroke dropped from the number four to the number five spot in leading causes of death in the United States. Stroke had a national age-adjusted mortality rate of 36.2 per 100,000 in 2013, with 128,978 people dying from stroke.\textsuperscript{3} Stroke was the fifth leading cause of death in Tennessee in 2013 with an age-adjusted mortality rate of 43.9 per 100,000, which amounts to a total of 3,123 people in the state.\textsuperscript{4} Tennessee is currently ranked number 45 in overall health outcomes according to America’s Health Rankings.\textsuperscript{5} It ranks 44 in deaths due to cardiovascular disease, including heart disease and stroke\textsuperscript{6} and 45 in occurrences of stroke.\textsuperscript{7}

Ischemic Strokes

Ischemic strokes are the most common type of cerebrovascular attack, making up approximately 87\% of stroke cases.\textsuperscript{1} In an ischemic stroke, blood flow to the brain is inhibited by the blockage of a blood vessel. In a process called atherosclerosis, fatty deposits of plaque collect in the inner lining of a vessel, reducing the amount of blood and oxygen delivered to vital organs. Plaque can rupture and break off into the blood stream, leading to thrombosis, the clotting of blood at the site of plaque rupture. Occlusion occurs when thrombosis leads to a complete blockage of the vessel, and when this vessel is responsible for supplying blood to the brain, can lead to an ischemic stroke. Blockage can also occur through cerebral embolism in which the blood clot forms at another, larger vessel in the circulatory system. Plaque then breaks off and can become lodged in a smaller vessel. When plaque gets lodged in the brain a stroke can occur. An irregular heartbeat, known as atrial fibrillation, is a common cause of clots that form in the heart, then dislodge and travel to the smaller vessels of the brain where they can become lodged, causing cerebral embolism.\textsuperscript{1} An estimated 30-40\% of ischemic strokes are cryptogenic strokes, or strokes of unknown cause.\textsuperscript{8}

Hemorrhagic Strokes

Hemorrhagic strokes result from the rupture of a blood vessel in the brain which can be caused by a variety of factors including aneurysms and arteriovenous malformations (AVMs).\textsuperscript{2} Aneurysms are regions of blood vessels that enlarge or “balloon” at a weakened site. People generally are not born with aneurysms, but develop them due to a constant pressure from blood flow. Aneurysms are associated with other vascular disorders such as fibromuscular dysplasia, cerebral arteritis and arterial dissection.\textsuperscript{9} They may also develop due to infections, drugs or direct brain trauma.\textsuperscript{9} AVMs occur as a result of the clustering of abnormally formed blood vessels. The cause of AVMs is unknown, but thought to be congenital, though not hereditary.\textsuperscript{10}

There are two types of hemorrhagic strokes: subarachnoid hemorrhage (SAH) and intracerebral hemorrhage (ICH). SAHs occur when a blood vessel on the surface of the brain ruptures and bleeds into the space between the brain and the skull. ICHs occur when the blood vessel that ruptures is deep within the brain.\textsuperscript{2}
Risk Factors:

The American Heart Association/American Stroke Association (AHA/ASA) recognizes the following risk factors for stroke:

- High blood pressure*
- Tobacco use
- Diabetes
- High blood cholesterol
- Physical inactivity and obesity
- Previous stroke/Transient Ischemic Attack (TIA)
- Sickle cell anemia
- Age – stroke risk increases with age
- Gender – each year, more women have strokes than men, and more women die of stroke
- Heredity
- Race – African Americans have a much higher risk of death from stroke than do Caucasians

*According to the Centers for Disease Control and Prevention (CDC) and AHA/ASA, hypertension, or high blood pressure, is the single most important risk factor of stroke to control for.  

AHA includes the following as other risk factors for stroke that require further research to determine the extent of the association:

- Excessive alcohol intake
- Geographic location – higher risk of stroke in the southeastern region of the US
- Socioeconomic factors – higher risk of stroke in low-income groups
- Drug abuse – increased risk of stroke has been associated with abuse of drugs including cocaine, amphetamines, and heroin

According to the AHA/ASA, about 80% of strokes are preventable. Understanding risk factors and taking the necessary precautions can help to minimize the occurrences of stroke. It has been estimated that more than half of strokes are caused by hypertension, making it one of the most important risk factors to control. People with hypertension, or high blood pressure, may be prescribed antihypertensive medication to control blood pressure and/or anticoagulant medications to prevent blood clotting. Some other risk factors to address when dealing with stroke prevention are tobacco use, physical inactivity and atrial fibrillation.
Stroke Symptoms

Time to treatment is critical to a stroke patient and can greatly impact recovery and survival. It is important to quickly recognize the signs and symptoms of stroke. The AHA/ASA recommends the F.A.S.T. technique to help people remember which signs to look for: Face drooping, Arm weakness, Speech difficulty, Time to call 911.

Image from the American Stroke Association website:
http://www.strokeassociation.org/STROKEORG/WarningSigns/Stroke-Warning-Signs-and-Symptoms_UCM_308528_SubHomePage.jsp

Other symptoms of stroke* may include the following14:

- Sudden numbness or weakness of the leg, arm, or face;
- Sudden confusion or trouble understanding people;
- Sudden vision impairment in one or both eyes;
- Sudden dizziness or loss of balance or coordination;
- Sudden severe headache;

* A key element to recognizing a stroke is noticing that these symptoms develop suddenly and with no other warning or explanation.

A Transient Ischemic Attack (TIA) can serve as a warning sign for a stroke. Often called a “mini-stroke,” a TIA is a temporary blockage of a vessel, usually lasting less than five minutes.15 The blockage dissolves on its own without medication and usually causes no permanent injury to the brain. Upon initial occurrence, a TIA cannot be distinguished from a stroke so it should be treated with the same medical promptness.
Treatment Options

Strokes require a variety of treatment options depending on their type and severity, as well as the amount of time prior to receiving medical care. Timeliness is critical in any stroke case. The longer a patient endures the symptoms of a stroke, the more brain cells are lost and the more brain tissue dies. As brain tissue is compromised, so is the outlook for a full recovery. Although, its ranking in the leading causes of death has dropped in recent years, stroke still remains a leading cause of serious, long-term disability.

In the case of ischemic stroke, where the flow of blood to the brain is blocked by a clot, the only FDA-approved treatment is tissue plasminogen activator (tPA), also known as the “clot-busting drug.” This intravenous therapy works by dissolving the clot and restoring blood flow to the brain. It must be initiated within three hours (and up to 4.5 hours in certain eligible patients) of the onset of a stroke symptoms. A newer treatment option for ischemic stroke patients is now available in many hospitals across the United States. This option involves an endovascular procedure, called mechanical thrombectomy, in which a wire cage, called a stent retriever, is used to remove the clot. Mechanical thrombectomy should be done within 6 hours of acute stroke symptoms and only after tPA has been administered.

For hemorrhagic strokes, surgery to repair the damaged blood vessel is also an option.

The Stroke Belt

The southeastern region of the United States is notorious for its high stroke mortality rates, so pronounced in fact that the area has earned the name “The Stroke Belt.” The National Heart, Blood, and Lung Institute defines the Stroke Belt as the following 11 states with an age-adjusted stroke mortality rate more than 10% greater than the national average: Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. This region was defined using 1980 stroke mortality data. What is the cause of this geographic disparity? According to a study published in the AHA Journal Stroke, 64-68% of excess stroke risk in the Southeast can be explained by race/ethnicity, socioeconomic status, risk factors, and chronic diseases.
A 1999 study reported that being born in the Stroke Belt state of South Carolina exhibited a significantly higher stroke risk as compared to those born outside of South Carolina and even more pronounced compared to those born outside of the Stroke Belt. This disparity is even more pronounced in blacks born in South Carolina compared to blacks born outside of the Stroke Belt than it is in whites born in South Carolina compared to those born outside of the Stroke Belt.

Geographic disparities may be exhibited by children as well. A study suggested that children in the Stroke Belt of the United States, like adults, exhibit a higher risk of death from stroke than children living outside of the Stroke Belt, even after adjusting for race and ethnicity. These findings seem to dispute earlier claims that the geographic variations in stroke mortality can be attributed to the differences in atherosclerotic stroke risk factors because such risk factors are not widely applicable to children.

The regional and racial differences seen in stroke mortality may be largely explained by the differences in stroke incidence. Although the incidence data for stroke is not as readily available, the REGARDS study conducted by the National Institute of Health showed that stroke incidence seemed to parallel stroke mortality data. The magnitude of the disparities among stroke incidence rate are not quite as pronounced as among mortality rates, suggesting that incidence rates only partially explain disparities in mortality rates.
Overview of GWTG-Stroke

In 2003, AHA/ASA initiated Get With the Guidelines-Stroke (GWTG-Stroke), a program which identifies the latest evidence-based guidelines for stroke treatment and care, and encourages hospitals to implement and track adherence to these guidelines through the GWTG-Stroke assessment and reporting system, the Patient Management Tool. Hospitals that participate in GWTG-Stroke are recognized for their participation and achievements.

Overview of Certified Stroke Centers

Hospitals are designated "Advanced Comprehensive Stroke Centers" or "Advanced Primary Stroke Centers" by the AHA/ASA in partnership with The Joint Commission (TJC). Primary Stroke Centers have stroke-focused programs and meet standards set by the AHA/ASA, as outlined by the Brain Attack Coalition. These standards support better outcomes for stroke care by utilizing the latest evidence-based guidelines of stroke care. Comprehensive Stroke Centers meet all the standards of Primary Stroke Centers in addition to further standards to treat the most complex stroke cases. As of June 29, 2016, there were 26 Primary Stroke Centers in the state of Tennessee and another five Comprehensive Stroke Centers. Information about stroke center certification is publicly accessible through TJC and AHA websites.
## Certified Stroke Centers in Tennessee as of 06/29/16*

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>City</th>
<th>Certification Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erlanger Health System</td>
<td>Chattanooga</td>
<td>Advanced Comprehensive Stroke Center</td>
</tr>
<tr>
<td>Fort Sanders Regional Medical Center</td>
<td>Knoxville</td>
<td>Advanced Comprehensive Stroke Center</td>
</tr>
<tr>
<td>The University of Tennessee Medical Center</td>
<td>Knoxville</td>
<td>Advanced Comprehensive Stroke Center</td>
</tr>
<tr>
<td>TriStar Skyline Medical Center</td>
<td>Nashville</td>
<td>Advanced Comprehensive Stroke Center</td>
</tr>
<tr>
<td>Vanderbilt University Medical Center</td>
<td>Nashville</td>
<td>Advanced Comprehensive Stroke Center</td>
</tr>
<tr>
<td>Baptist Memorial Hospital - Memphis</td>
<td>Memphis</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Blount Memorial Hospital, Inc.</td>
<td>Maryville</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>CHI Memorial</td>
<td>Chattanooga</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Jackson-Madison County General Hospital</td>
<td>Jackson</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Johnson City Medical Center</td>
<td>Johnson City</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Methodist Le Bonheur Germantown Hospital</td>
<td>Germantown</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Methodist North Hospital</td>
<td>Memphis</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Methodist South Hospital</td>
<td>Memphis</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Methodist University Hospital</td>
<td>Memphis</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>NorthCrest Medical Center</td>
<td>Springfield</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>North Knoxville Medical Center</td>
<td>Powell</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Saint Francis Hospital - Bartlett</td>
<td>Bartlett</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Saint Francis Hospital-Memphis</td>
<td>Memphis</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Saint Thomas Midtown Hospital</td>
<td>Nashville</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Saint Thomas Rutherford Hospital</td>
<td>Murfreesboro</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Saint Thomas West Hospital</td>
<td>Nashville</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Southern Hills Medical Center</td>
<td>Nashville</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>StoneCrest Medical Center</td>
<td>Smyrna</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Sumner Regional Medical Center</td>
<td>Gallatin</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>TriStar Centennial Medical Center</td>
<td>Nashville</td>
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</tr>
<tr>
<td>TriStar Hendersonville Medical Center</td>
<td>Hendersonville</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>TriStar Horizon Medical Center</td>
<td>Dickson</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>TriStar Summit Medical Center</td>
<td>Hermitage</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Turkey Creek Medical Center</td>
<td>Knoxville</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Wellmont Bristol Regional Medical Center</td>
<td>Bristol</td>
<td>Advanced Primary Stroke Center</td>
</tr>
<tr>
<td>Wellmont Holston Valley Medical Center</td>
<td>Kingsport</td>
<td>Advanced Primary Stroke Center</td>
</tr>
</tbody>
</table>

*This list was last updated on June 29, 2016. The most up-to-date listing of certified stroke centers can be found on The Joint Commission website or American Heart/American Stroke Association website.

Following a stroke, time to treatment can have a major impact on long-term outcomes\(^{21,22}\). For this reason, a map was generated to show the locations of all 31 certified stroke centers in Tennessee, and 11 centers in surrounding states, in order to illustrate the estimated travel time to a stroke center from any point in the state. This information was then overlaid onto a map of 2014 stroke mortality data for Tennessee. Methods for the maps can be found in the appendix (page 29) of this report.
Map 1: Map of Stroke Centers and Travel Time illustrates the 2014 stroke mortality rates per 100,000 for each county in Tennessee (A) and shows the location of the current 31 certified stroke centers in Tennessee (listed on the previous page) and the 11 stroke centers in bordering states within 50 miles of the Tennessee border and travel times to each stroke center are mapped for 30, 60 and 90 minutes (B). The map of 30-, 60- and 90-minute service areas were then overlaid onto the map of mortality data (C).
Map 2: Analysis of Tennessee Population Served by Certified Stroke Centers illustrates the percentages of Tennessee’s population served within 30, 60, and 90 minutes of a certified stroke center.
In 2015, 12 hospitals reported 7,185 cases of stroke and TIAs to the Tennessee Stroke Registry (TSR) as of June 9, 2016. The following charts and tables illustrate the data reported by 12 TSR-reporting hospitals in 2015. For the purpose of analyzing the data presented to the TSR, all reports were generated on June 9, 2016 and include all cases reported between January 1, 2015 and December 31, 2015. All analyses include TIA patients unless otherwise stated. Although not a true stroke diagnosis, understanding the characteristics of TIAs can help to identify areas of concern.

According to AHA/ASA, more women than men have strokes and more women than men die from strokes each year\textsuperscript{11}. Some research has attributed this to the fact that women generally have longer life expectancies and experience stroke at an older age than men\textsuperscript{23}.
When looking at gender distributions (Figure 2) among different stroke types, there were statistically significant differences between proportion of males and females for all strokes, for TIA, and for subarachnoid hemorrhages (SAHs). Among TIA patients, there are more females than males (54% vs. 46%, \( z = 2.291, p = 0.0220 \)). SAH shows the most distinguishable difference in gender distribution with 63% of patients being female (\( z = 5.200, p < 0.0001 \)). An observation of the sample sizes for each of the stroke types raises the question of potential bias due to small sample size in SAHs. Because nationally only approximately 3% of all stroke cases are SAHs,\(^{24}\) little information is available on that specific subtype. Future research may consider further investigating gender disparities within stroke subtypes, especially SAHs, as suggested by these data.

**Figure 2: Gender Distribution across Various Types of Stroke** shows the gender distribution of all stroke patients and across different stroke types and TIA where gender was reported. For each chart, “n” represents the number of patients of that stroke type for which gender was reported.
Figure 3: Age Distribution across All Stroke Types illustrates the age distribution across all stroke types of the 7,181 files with age reported for patients 18 years and older. The average age for stroke of patients seeking care at TSR-reporting hospitals in 2015 was 67.1 years old.
Age Distribution across Various Stroke Types

Figure 4: Age Distribution across Various Stroke Types shows the distribution of age groups across the different types of stroke.
Referring to Figure 3, 56% of all stroke and TIA patients are 66 or older. When broken-down by stroke type (Figure 4), only subarachnoid hemorrhage strokes (4c) exhibit a distribution with less than 50% of patients being older than 66 years. In fact, 69% of subarachnoid hemorrhages reported to the TSR were of patients younger than 66 years. The average age for SAH was 58.2 years compared with the average age for all stroke types, 67.1 years. Figure 6 shows average ages and one standard deviation for each subtype of stroke with “n” representing the number of patients of each subtype with age recorded.

Figure 5: Average Ages of Stroke Subtypes +/- 1 Standard Deviation

shows the average ages and one standard deviation for each subtype of stroke with “n” representing the number of patients of each subtype with age recorded.

Referring to Figure 3, 56% of all stroke and TIA patients are 66 or older. When broken-down by stroke type (Figure 4), only subarachnoid hemorrhage strokes (4c) exhibit a distribution with less than 50% of patients being older than 66 years. In fact, 69% of subarachnoid hemorrhages reported to the TSR were of patients younger than 66 years. The average age for SAH was 58.2 years compared with the average age for all stroke types, 67.1 years. Figure 6 shows average ages and one standard deviation for each stroke subtype which are statistically different (F (3, 7,146) = 64.146, p < 0.0001). Various studies claim differences between the mean age of ischemic and hemorrhagic stroke patients\textsuperscript{25} and differences in risk factors between older (65-98 years) and younger (20-64 years) patients\textsuperscript{26} but few have addressed age differences between SAH and ICH strokes which were found to be significant by these analyses (F (1, 1,333) = 67.742, p < 0.0001).
Figure 6, reporting co-morbidities among stroke patients, reemphasizes the AHA claim that hypertension is the most important stroke risk factor to control for,\textsuperscript{11} with 75.1\% of stroke patients having a prior diagnosis of hypertension.

Figure 6: Co-morbidities among Stroke Patients shows the top seven co-morbidities of the 7,126 files with a co-morbidity recorded with the corresponding percentage of patients with that co-morbidity. Percentages total to more than 100\% due to multiple co-morbidities among patients.

<table>
<thead>
<tr>
<th>Co-morbidity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>75.1%</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>39.3%</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>32.7%</td>
</tr>
<tr>
<td>Previous Stroke</td>
<td>24.7%</td>
</tr>
<tr>
<td>CAD/Prior MI</td>
<td>24.5%</td>
</tr>
<tr>
<td>Smoker</td>
<td>21.6%</td>
</tr>
<tr>
<td>Atrial Fib/Flutter</td>
<td>15.1%</td>
</tr>
</tbody>
</table>

![Graph showing co-morbidities among stroke patients](image)
For all strokes and ischemic strokes, the differences between the distributions of different arrival modes are subtle compared to TIAs and hemorrhagic strokes. The majority of TIA patients (55.0%) arriving to TSR-reporting facilities traveled by private transportation. Because TIAs have temporary symptoms with generally no long-term consequences\textsuperscript{15}, the lower proportion of transferred patients could be expected. In the case of hemorrhagic strokes, very few patients traveled to the facility by means of private transportation, with most (57.4%) arriving as a transfer from another facility. Only 10.1% of hemorrhagic stroke patients traveled to a TSR-reporting facility via private transportation. This greatly increased proportion of transferred patients for hemorrhagic stroke may be at least partially explained by the fact that all hospitals reporting data to the TSR are certified stroke centers, suggesting that hemorrhagic stroke patients tend to transfer to these hospitals for specialized care.

\textbf{Figure 7: Arrival Mode by Stroke Type} shows the distribution of different modes of arrival to the hospital by type of stroke. While the differences between arrival mode among all strokes and ischemic strokes appears to be fairly subtle, differences are more apparent for TIAs and hemorrhagic stroke.

For all strokes and ischemic strokes, the differences between the distributions of different arrival modes are subtle compared to TIAs and hemorrhagic strokes. The majority of TIA patients (55.0%) arriving to TSR-reporting facilities traveled by private transportation. Because TIAs have temporary symptoms with generally no long-term consequences\textsuperscript{15}, the lower proportion of transferred patients could be expected. In the case of hemorrhagic strokes, very few patients traveled to the facility by means of private transportation, with most (57.4%) arriving as a transfer from another facility. Only 10.1% of hemorrhagic stroke patients traveled to a TSR-reporting facility via private transportation. This greatly increased proportion of transferred patients for hemorrhagic stroke may be at least partially explained by the fact that all hospitals reporting data to the TSR are certified stroke centers, suggesting that hemorrhagic stroke patients tend to transfer to these hospitals for specialized care.
Time from Last Known Well to Arrival by Mode of Transportation for Patients Arriving within 3 Hours

**Figure 8a: Time from Last Known Well to Arrival**

*by Mode of Transportation of Patients Arriving within 3 Hours* shows the percentages of patients of each mode of transportation (private and EMS) that arrived within the specified time period. The total number for each mode of transportation is limited to patients arriving within 3 hours of last known well (LKW). Of the 454 patients arriving by private transport within 3 hours, 38.5% arrived within 60 minutes. Of the 1,066 patients arriving by EMS within 3 hours of LKW, 36.9% arrived within 60 minutes.

*“Time from Last Known Well to Arrival” is defined as the amount of time between when the patient first began experiencing stroke symptoms and their arrival at the hospital.*

Time from Last Known Well to Arrival by Mode of Transportation for Patients Arriving within 5 Hours

**Figure 8b: Time from Last Known Well to Arrival**

*by Mode of Transportation of Patients Arriving within 5 Hours* shows the percentages of patients of each mode of transportation (private and EMS) that arrived within the specified time period. The total number for each mode of transportation is limited to patients arriving within 5 hours of last known well (LKW). Of the 553 patients arriving by private transport within 5 hours of LKW, 31.6% arrived within 60 minutes. Of the 1,274 patients who arrived by EMS within 5 hours of LKW, 30.8% arrived within 60 minutes.
Figure 8a illustrates that of the patients arriving within 3 hours of time of last known well (the cut-off time to administer tPA for eligible patients), although more patients arrived by EMS than by private transport (1,066 vs. 454), a slightly larger percentage of those traveling by private transport arrived at the hospital within one hour of time of last known well. One possible explanation to this phenomenon is a delay in calling EMS. Another explanation may involve access to EMS.

When taking into consideration all patients arriving within 5 hours of time of the last time they were known to be well (Figure 8b), again, a slightly larger percentage of those traveling by private transport arrived within one hour of time of last known well. A significantly greater proportion of the patients using private transportation who arrived within 5 hours, arrived more than 3 hours after time of last known well (25.7% vs. 16.3%, \( z = 4.7, p < 0.0001 \)). This is a critical point because patients who arrive more than 3 hours after time of last known well are generally no longer eligible for tPA.

When considering all patients’ arrival times (Figure 8c), a large percentage of patients arrive more than three hours after stroke symptoms begin, disqualifying a majority of stroke patients for tPA and further limiting their recovery outlook. Reasons for delayed arrival should be identified and addressed in order to improve stroke outcomes in Tennessee.

**Figure 8c: Time from Last Known Well to Arrival by Mode of Transportation for all Patients** shows the percentage of patients arriving within each time interval for 2,110 patients arriving by private transportation and another 2,554 patients arriving by EMS. The “> 300” group includes patients who arrived more than one day after initial stroke symptoms and patients whose time of initial stroke symptoms was unknown.
As shown in Figure 9, the majority of stroke patients (61.7%) accounted for in the TSR had Medicare insurance. People are generally eligible for Medicare at the age of 65 and a large proportion of stroke patients (56%) reported in the TSR are over the age of 65. The differences in these percentages may be reflected by a small number of people who are 65 or younger, but qualify for Medicare due to disabilities. It is possible that these disabilities which qualify them for Medicare are also associated with increased risk of stroke.
The GWTG-Stroke program requires reporting of the following consensus measures with descriptions extracted from the Patient Management Tool program, Quintiles:

- **IV rt-PA Arrive by 2 Hour, Treat by 3 Hours**: Percent of acute ischemic stroke patients who arrive at the hospital within 120 minutes (2 hours) of time last known well and for whom IV t-PA was initiated at this hospital within 180 minutes (3 hours) of time last known well.
- **Early Antithrombotics**: Percent of patients with ischemic stroke or TIA who receive antithrombotic therapy by the end of hospital day two.
- **VTE Prophylaxis**: Percent of patients with an ischemic stroke, or a hemorrhagic stroke, or stroke not otherwise specified who receive VTE prophylaxis the day of or the day after hospital admission.
- **Antithrombotics**: Percent of patients with an ischemic stroke or TIA prescribed antithrombotic therapy at discharge.
- **Anticoag for AFib/Aflutter**: Percent of patients with an ischemic stroke or TIA with atrial fibrillation/flutter discharged on anticoagulation therapy.
- **Smoking Cessation**: Percent of patients with ischemic or hemorrhagic stroke, or TIA with a history of smoking cigarettes, who are, or whose caregivers are, given smoking cessation advice or counseling during hospital stay.
- **LDL 100 or ND – Statin**: Percent of Ischemic stroke or TIA patients with LDL ≥ 100, or LDL not measured, or on cholesterol-reducer prior to admission who are discharged on Statin Medication.
- **Dysphagia Screen**: Percent of Stroke patients who undergo screening for dysphagia with an evidence-based bedside testing protocol approved by the hospital before being given any food, fluids, or medication by mouth.
- **Stroke Education**: Percent of patients with Stroke or TIA or their caregivers who were given education and/or educational materials during the hospital stay addressing ALL of the following: personal risk factors for stroke, warning signs for stroke, activation of emergency medical system, need for follow-up after discharge, and medications prescribed.
- **Rehabilitation Considered**: Percent of patients with Stroke who were assessed for rehabilitation services.

<table>
<thead>
<tr>
<th>Quality Measure</th>
<th>Numerator</th>
<th>Denominator</th>
<th>% of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV rt-PA Arrive by 2 hour, Treat by 3 hour</td>
<td>449</td>
<td>499</td>
<td>90.0%</td>
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<tr>
<td>Early antithrombotics</td>
<td>3062</td>
<td>3127</td>
<td>97.9%</td>
</tr>
<tr>
<td>VTE Prophylaxis</td>
<td>4822</td>
<td>5001</td>
<td>96.4%</td>
</tr>
<tr>
<td>Antithrombotics</td>
<td>4316</td>
<td>4347</td>
<td>99.3%</td>
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<tr>
<td>Anticoag for Afib/Aflutter</td>
<td>639</td>
<td>676</td>
<td>94.5%</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>1155</td>
<td>1217</td>
<td>94.9%</td>
</tr>
<tr>
<td>LDL 100 or ND - Statin</td>
<td>3176</td>
<td>3279</td>
<td>96.9%</td>
</tr>
<tr>
<td>Dysphagia Screen</td>
<td>4474</td>
<td>4970</td>
<td>90.0%</td>
</tr>
<tr>
<td>Stroke Education</td>
<td>2881</td>
<td>3041</td>
<td>94.7%</td>
</tr>
<tr>
<td>Rehabilitation Considered</td>
<td>4783</td>
<td>4855</td>
<td>98.5%</td>
</tr>
</tbody>
</table>

*Table 2. GWTG Consensus Measures* shows the achievements of each consensus measure among eligible patients for all TSR-reporting hospitals. The goal for each measure is 100%. Because not all patients with a recorded stroke diagnosis qualify for each of the consensus measures, the numerator and denominator are given for each measure.
Limitations to the Data Presented in this Report

The Tennessee Stroke Registry reports on data input voluntarily by hospitals through the AHA’s Patient Management Tool, the GWTG assessment and reporting system. All 31 hospitals that participate in GWTG-Stroke are eligible to input data into the Patient Management Tool for the Tennessee Stroke Registry. Fourteen hospitals in the state are enrolled in the registry and of those 14, 12 hospitals have entered data for 2015. The numbers alone prove to be a major obstacle to producing a comprehensive report.

Twelve hospitals have reported 6,365 (as of 6/9/16) cases of stroke (excluding TIA) to the Tennessee Stroke Registry for 2015. The prevalence of stroke in Tennessee is greatly underreported in the TSR due to the low number of participating hospitals. This is estimated to reflect less than 25% of actual stroke occurrences in the state based on Hospital Discharge data from 2013 which shows records of 27,209 strokes. While this is an improvement in the amount of participation from last year’s report, which contained data from only six hospitals in Tennessee, there remains opportunities for improvement in data collection among facilities.
How to Participate in Get With the Guidelines-Stroke

Information on enrolling in GWTG-Stroke can be found at the following website:

The local GWTG contact is Jared Ellis, who can assist hospitals in enrolling in GWTG-Stroke and the Tennessee Stroke Registry.

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Appendix

Methods for mapping mortality data: A shapefile of Tennessee counties boundaries was obtained from the TIGER/Line dataset on the US Census website and a new column was added to incorporate county-level stroke mortality rates obtained from Tennessee Department of Health’s 2014 Death Statistics webpage. A map was generated in ArcGIS 10.3.1 to illustrate the rates of stroke mortality by county by varying colors for 5 intervals of mortality rates using the quantile method of classification within ArcMap which places equal numbers of enumerations into each category. Stroke mortality rates in Tennessee in 2014 ranged from 26.3 per 100,000 to 135.7 per 100,000.

Methods for mapping service areas: Facilities (n=42) were geocoded in QGIS using the Google geocoder. A shapefile for the geocoded facilities (n=42) was created and the road network was delineated using the Network Analyst toolbar within ArcMap 10.3.1. A road network was downloaded from the National Highway Planning Network dataset. Once the network dataset was created in the road file, service areas for 30, 60, and 90 minutes were generated using the Service Areas creation tool in Network Analyst.

Methods for mapping population served: The service area layer was copied from service area analysis. Data were extracted for service area polygons, then each of the three service areas was extracted separately, resulting in three polygons representing the three service areas. Population data was clipped to each service area. The statistics feature was used to calculate the population total within each clipped area. The sum of each clipped population polygon was divided by the total population of Tennessee (n = 6,346,105) to yield the percentage of the population within each service area.
References


15. TIA (Transient Ischemic Attack). *Am Stroke Assoc.*


27. **Number of Outpatient Visits with Emergency Department Services, by First Listed Diagnosis, Age Group and Percent of Age Group, Tennessee Short Term Hospitals 2012.** 2012.

28. **Number of Inpatient Hospital Discharges with Emergency Department Services, by First Listed Diagnosis, Age Group and Percent of Age Group, Tennessee Short Term Hospitals 2012.** 2012.