5-2020

A Protocol Driven Stroke Code's Impact on Door-to-Needle Times

Jesse Osborne
East Tennessee State University

A Protocol Driven Stroke Code's Impact on Door-to-Needle Times

---

A thesis

presented to

the faculty of the Department of Allied Health

East Tennessee State University

In partial fulfillment

of the requirement for the degree

Master of Science in Allied Health

---

by

Jesse A. Osborne

May 2020

Dr. Randy Byington

Dr. Ester Verhovsek-Hughes

Dr. Deborah Dotson

Keywords: stroke protocols, stroke code, tPA, door-to-needle time

ABSTRACT

A Protocol Driven Stroke Code's Impact on Door-to-Needle Times

by

Jesse Osborne

Tissue plasminogen activator (tPA) is most effective the faster it is able to be administered to a patient that has been affected by stroke. A Stroke Code is a strategy that acute care facilities implement to reduce the time from diagnosing a stroke to administering tPA. The purpose of this study was to determine if the initiation of a Stroke Code in an acute care hospital reduces the door-to-needle time for patients affected by a stroke. In particular, does a Stroke Code reduce door-to-needle times. The research was conducted using data from April 1, 2014 to December 31, 2014 (pre-Stroke Code period) and September 1, 2015 to December 31, 2016 (post-Stroke Code period). The population of this study was treated at Holston Valley Medical Center in Kingsport, Tennessee. The analysis revealed a decrease in door-to-needle times after a Stroke Code was implemented at the acute care facility.

AKNOWLEDGEMENTS

I thank each and every one of my committee members: Dr. Randy Byington, Dr. Ester Verhovsek-Hughes, and Dr. Deborah Dotson for all of the assistance they have given in the creation of every aspect of this thesis. I also say a special thanks to Dr. Byington, my committee chair, for assisting me in finalizing the statistical portion of my thesis and helping bring this project to completion.

Extended thanks to Dr. Shirley Cherry for assistance of the literature review and the initiation of this thesis. Another special thanks to Tammy Wright, the HVMC Stroke Coordinator at the time of data retrieval, for assisting with the data used for this research.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

A stroke is a cerebrovascular attack that is life threatening and may cause debilitating side effects. Strokes can be either hemorrhagic or ischemic; while both have adverse effects to the brain, there are different treatment options. Since the outcome of stroke treatment is time dependent, it is vital that practitioners minimize their response time when caring for individuals who may have been affected by a stroke. Because the time window for a patient who has experienced a stroke to receive tissue plasminogen activator (tPA) treatment is up to 4.5 hours (Hacke et al., 2008, p. 2839), health care providers must quickly diagnose and prepare patients for treatment.

A technique to minimize the time from diagnosis to treatment for those impacted by stroke is the activation of a Stroke Code. A Stroke Code is a notification sent to a multidisciplinary team to inform them that a patient may be experiencing a stroke. As a result of the initiation of a Stroke Code, providers implement a set of diagnostic protocols used to evaluate the patient. These protocols include collection of samples for submission of predetermined laboratory testing and imaging (CT or MRI) of the brain with interpretation by a radiologist. A Stroke Code is initiated to reduce the time it takes health care providers to recognize a stroke, transfer the patient to the appropriate treatment location, receive the proper laboratory and imaging test results, and decrease overall door-to-needle times. A successful Stroke Code increases the efficiency and effectiveness of treating patients.

Statement of the Problem

Since the timeframe allotted to treat patients with a stroke is of utmost importance, health care organizations must have predetermined protocols that allow effective treatment for patients

suspected of a stroke. If patients who experienced a stroke are not treated within a certain amount of time, the options for treating a stroke are vastly decreased. Therefore, the initiation of a Stroke Code will be evaluated to determine if it is a viable option for acute care settings to reduce diagnostic times to prepare the patient for treatment.

Purpose of the Study

The purpose of this study was to determine if the initiation of a Stroke Code in an acute care hospital reduces the door-to-needle time for patients affected by a stroke. The study also sought to determine which protocols within the Stroke Code process may be effective and which may be ineffective in decreasing the time from diagnosis to treatment. Disease specific protocols, such as those used for patients presenting with stroke-like symptoms, can be vital in assuring patients receive appropriate treatment. A Stroke Code may lead to a more responsive and unified approach of health care providers when presented with a patient who had stroke-like signs and symptoms. Emergency department (ED) staff treat increasingly high numbers of patients, and a Stroke Code that prioritizes patients can be beneficial.

Delimitations

The study was delimitated to the patients of Holston Valley Medical Center, a tertiary care hospital located in northeast Tennessee. The study was further delimited to patients presenting from April 2014 until December 2014, a time when the facility did not use a Stroke Code intervention. Data was further collected post Stroke Code implementation from September 2015 to December 2016.

Research Questions

The following questions guided this project:

1. Is there a significant difference in the time from patient arrival to physician assessment between pre- and post-Stroke Code periods?
2. Is there a significant difference in the times from patient arrival to receiving radiology report on patients between the pre- and post-Stroke Code periods?
3. Is there a significant difference in times from patient arrival to receiving lab results between the pre- and post-Stroke Code periods?
4. Is there a significant difference in times of patient arrival to completing an EKG on patients during designated pre- and post-Stroke Code periods?
5. Is there a significant difference in the door-to-needle times between the pre- and post-Stroke Code periods?

Limitations

Certain factors did limit the data collected in this study. Those factors are as follows:

1. Patients who had advanced directives declining life saving measures were not included in the study.
2. The Stroke Code protocols are in a constant state of alteration to maximize the fastest and most accurate diagnosis of a stroke. Changes in protocols may affect the consistency of data collected.

Definition of Terms

For the purposes of this study, these words were defined as follows:

- Basic Metabolic Panel (BMP) – a blood test to evaluate levels of glucose, calcium, sodium, potassium, carbon dioxide, chloride, blood urea nitrogen, and creatinine.

- Cincinnati Prehospital Stroke Scale – numerical scale used to visually assess for potential stroke.
- Complete Blood Count (CBC) – a blood test to evaluate the levels of red blood cells, white blood cells, hemoglobin, hematocrit, and platelets.
- Computed Tomography Scan (CT) – imaging modality using x-rays to capture sectional anatomy that allows health care providers to visualize areas of interest.
- Door-to-needle (DTN) – term used to explain the time from when a patient that has experienced a stroke arrives at the hospital until surgical or medical intervention is performed.
- Emergency Medical Services (EMS) – individuals responsible for prehospital care of patient seeking medical attention and/or transportation to the Emergency Department.
- Hemorrhagic stroke –occurs when a blood vessel ruptures and blood runs into the brain.
- I BEST Program - modified Stroke Code the in-hospital brain salvage through emergent stroke therapy (I-BEST program). The I-BEST is derived from the BEST program, which is a Stroke Code aimed at OHS patients.
- In-hospital stroke (IHS) – stroke that occurs after a patient is admitted to the hospital.
- Ischemic stroke – result of obstruction within a blood vessel supplying blood to the brain.
- Magnetic Resonance Imaging (MRI) – imaging modality using a magnetic field and radiowaves to capture sectional anatomy to visualize areas of interest.

- Out-of-hospital stroke (OHS) – stroke that occurs when a patient is not hospitalized.
- Protocol – policy that determines a process to be performed in a particular situation.
- Stroke – occurs when a vessel in the brain ruptures or is obstructed by a foreign object (often blood clot, fat, bone, etc.).
- Stroke Code – notification to multiple health care providers to inform them that a patient may have had a stroke.
- Thrombolysis – using medication to break down clots that occur in vessels.
- Tissue plasminogen activator (tPA) – FDA approved treatment for ischemic stroke.

CHAPTER 2

LITERATURE REVIEW

Stroke Code

The core concept of treating a patient who has experienced a stroke is to medically intervene as quickly as possible. Acute care facilities implement a Stroke Code (SC), also known as a Code Stroke, to decrease the time from stroke diagnosis until the time medical intervention takes place. Stroke Codes are intended to reduce the door-to-needle times and help achieve treatment within The Golden Hour. Advani, Naess and Kurz (2017) explained "that treatment within 60 minutes of symptom onset produces excellent outcomes with significantly lower rates of morbidity and mortality" (p. 1). Chen et al. (2014) included research from a health care facility that uses a Stroke Code that ". . . involves the cooperation and integration of the emergency, radiology, laboratory medicine, and neurology staff who conduct the initial assessment, imaging, and evaluation of acute ischemic stroke patients to expedite acute stroke treatment, particularly with IV-tPA" (p. 2). Chen et al. (2014) stated "acute stroke care implemented with 'Stroke Code' (SC) or similar strategies is reported in several studies to enhance IV-tPA administration and reduce door-to-needle (DTN) time" (p. 1). A Stroke Code team is multidisciplinary; members have clearly defined roles to provide treatment in a timely manner. In the Chen et al. (2014) study, a triage nurse notified the emergency department ED physician who determined if the Stroke Code should be initiated (Chen et al., 2014). Other researchers based their study on a Stroke Code initiated by Emergency Medical Services (EMS) (Kim et al., 2016; Tai, Weird, Hand, & Davis, 2011). If and when the Stroke Code is initiated, a series of evaluation, imaging, laboratory testing, and intervention (if applicable) will begin to take place in a predetermined order. Ultimately, Chen et al. (2014) discovered that

> …implementation of a SC significantly increases IV-TPA administration and significantly shortens DTN time. SC usage was associated with a 13-minute reduction in door-to-CT time, a 37-minute reduction in DTN time, a 5-fold increase in the percentage of patients reaching the DTN goal of ≤ 60 minutes, and a trend toward better functional outcomes without increases in symptomatic ICH (intracerebral hemorrhage) or mortality rate. (Chen et al., 2014, p. 6)

Tai et al. (2011) stated "the diagnosis of 'time-critical therapy' such as stroke made in emergency departments has been reported to be delayed and less accurate in the absence of effective protocols" (p. 1316). Prior to implementation of Stroke Codes in acute care settings, information vital to a patient's outcome was relayed without a system to improve treatment times. The lack of protocols that organized diagnostic tools to determine a stroke often leads to a delay in recognizing a stroke and ultimately decreased the ability to medically intervene. In the Tai et al. (2011) study, "the code stroke system aims to reduce delays in assessment and investigation of patients, thereby increasing rates of thrombolysis" (p. 1317). The researchers collected data pre-code stroke era (January 2003 to June 2007) of patients who underwent thrombolysis and compared it to patients who underwent the same treatment during the code stroke era (July 2007 to December 2010) (Tai et al., 2011). Tai et al. (2011) concluded that:

> … an implemented code stroke system was associated with a 20% relative reduction in door-to-needle time, 18% relative reduction in door-to-CT time, and an increase in IV-tPA usage from 3.9% to 17.3% while maintaining a low proportion of death. (p. 1320)

There are differences in the initiation of a Stroke Code for patients in the hospital and those being transported to the hospital for a suspected stroke. These Stroke Codes are still intended to efficiently and effectively treat patients. Husseini and Goldstein (2013) stated

"stroke rapid-response teams ("code strokes") are intended to provide expeditious clinical expertise to support the evaluation and timely treatment of patients sustaining acute stroke" (p. 345). The researchers reported differences in the effectiveness of Stroke Codes for hospitalized and non-hospitalized patients. Husseini and Goldstein (2013) "found that code strokes in hospitalized patients were frequently activated for a host of stroke mimics that commonly did not necessitate immediate neurologic care" (p. 347). The authors concluded that this could be the lack of physician initiating the Stroke Code (common in ED settings) or staff members not being educated on the signs and symptoms of a stroke. Many Stroke Codes in their study were activated when patients were identified as having altered mental status. Husseini and Goldstein (2013) suggested that "developing a standardized assessment protocol for hospitalized patients with altered mental status might improve the efficiency of care by allowing more appropriate initial evaluation" (p. 348).

Yoo et al. (2016) agreed with Husseini and Goldstein (2013) that "time delay to reperfusion therapy is common in patients with in-hospital stroke (IHS) and many patients are not treated rapidly as would be expected" (p. 657). Even though research is more suggestive of the benefits for Stroke Codes for out-of-hospital stroke (OHS) compared to in-hospital stroke, IHS Stroke Codes are still effective. Yoo et al. (2016) argued that "patients with IHS are potentially good candidates for reperfusion therapy. . . . They have advantages over those with OHS, including saved time due to not requiring transport to a hospital from the place where the stroke developed" (p. 657). Yoo et al. (2016) named their modified Stroke Code the in-hospital brain salvage through emergent stroke therapy (I-BEST program). The I-BEST is derived from the BEST program, which is a Stroke Code aimed at OHS patients. Yoo et al. (2016) concluded that "the study showed that I-BEST program was effective in reducing time intervals from

symptom onset to reperfusion therapy in patients with IHS" (p. 658) and that "this finding supports wide implementation of this program for patients with IHS" (p. 661).

According to Sattin, Olson, Liu, Raman, and Lyden (2006) "the odds of favorable outcome appear to decline over time, implying that treatment should be rendered as early as possible" (p. 2935). The researchers explained that their "expedited code stroke protocol avoids delays for tests that we believe contribute little to the evaluation of the patient's suitability for thrombolysis" (Sattin et al., 2006, p. 2398). The researchers modified their Code Stroke such that "if the impression suggests that the patient may benefit from rt-PA, the drug is brought to the bedside unmixed pending further evaluation" (Sattin et al., p. 2935). Having the thrombolytic medication bedside was a tactic used to reduce time of medication delivery instead of having to wait until the end of evaluation before an order was put forth to receive the medication from the pharmacy. Sattin et al. (2006) concluded that the "expedited code stroke protocol is feasible and appears safe" (p. 2939).

Imaging

An important part of the Stroke Code process is the type of imaging that must be performed during a Stroke Code. The patient must undergo imaging to confirm that a stroke has indeed occurred. Wintermark et al. (2008) stated that "acute stroke patients should undergo either a 'baseline' MRI or CT study" (p. 1622).

> Baseline MRI sequences should include: scout image, diffusion-weighted imaging 3D time-of-flight MR-angiogram (MRA) of the intracranial arteries, gradient-recalled echo (GRE) imaging, perfusion-weighted imaging, and T2-fluid attenuated inversion recovery (FLAIR). The baseline CT study should include: noncontrast CT, perfusion CT, CT-

angiography (CTA), and contrast-enhanced CT) (Wintermark et al., 2008, pp. 1622-1623).

The researchers primarily focused on different types of imaging required for the entire treatment of stroke, "(1) the initial parenchymal and vascular state, (2) the biological effect of the intervention, (3) the occurrence of early hemorrhagic transformation, and (4) the final tissue outcome" (Wintermark et al., 2006, p. 1622). The researchers included two guidelines regarding the type of imaging modality used to diagnosis a stroke: "1. A standard set of imaging sequences to be performed at specific time points; and 2. a standardized image processing toolbox to analyze these imaging sequences to extract quickly (ideally subminute but certainly <5 minutes) necessary for information of the selection of acute stroke patients for acute therapies" (Wintermark et al., 2006, p. 1626).

Chalela et al. (2007) conducted a study to "prospectively compare CT and MRI for the detection of acute stroke in the full range of patients who present for emergency assessment of stroke-like symptoms" (p. 293). While a "CT is the most common imaging tool to assess for acute stroke; it is cheaper to perform and is more easily assessable than MRI" (Chalela et al., 2007, p. 297), an MRI may be more reliable in detecting acute stroke and have benefits in determining if findings are acute or chronic. To determine the most effective scan to perform in the case of suspected acute stroke, Chalela et al. conducted a 2-year study on patients referred to the hospital's Stroke Team because of suspected acute stroke. An MRI was performed initially, followed by a CT. Limitations did exist in the study including metallic material in the patient and time restraint to treat stroke therapeutically. Once imaging was available, two neuroradiologists and two stroke neurologists interpreted the images. For conformation of the

findings, stroke had to be recognized by three out of the four interpreters (Chalela et al., 2007). Chalela et al. (2007) determined that

> MRI can be used as the sole modality for the emergency imaging of patients with suspected acute stroke, whether ischaemic or haemorrhagic. The high diagnostic accuracy of MRI was the same for scans within the first 3 hours as it was for the entire sample, and thus is relevant to patients who might be eligible for standard thrombolytic treatment of stroke (p. 297).

Chalela et al. (2007) did not include any information about which scan took less time to perform, which would be valuable information in deterring the type of imaging for a Stroke Code situation but confirmed that "MRI is more effective for detection of acute ischaemia and can detect acute and chronic haemorrhage. It should be the preferred test for accurate diagnosis of patients with suspected acute stroke" (Chalela et al., 2007, p. 298).

Chalela et al. (2007) and Wintermark et al. (2006) agreed that MRI is the better imaging modality to determine an acute stroke. On the other hand, several researchers concluded that a noncontrast CT scan is the preferred modality because of it being less expensive and quicker to perform (Chen et al., 2014, Husseini and Goldstein, 2013, Sattin, Olson, Liu, Raman, & Lyden, 2006, Tai et al., 2012, and Yoo et al., 2016).

Medical Providers

An interdisciplinary group of medical providers is necessary to perform a Stroke Code. Stroke Codes often used different combinations of team members to deliver fast evaluation and treatment of individuals believed to be affected by a stroke. Stroke Codes "involved emergency triage, assessment by an emergency physician, ordering of investigations and prompt referral to the stroke team through switchboard to all members of the Code Stroke team, each of whom

possess a linked pager" (Tai et al., 2011, p. 1317). By having all the team members connected via pagers, there could be a faster initiation of the Stroke Code protocols. Before this was implemented, the notifications were often slow and referrals were directed to the wrong neurological providers (neurology registrar vs. stroke registrar) (Tai et al., 2011, p. 1317).

The Stroke Code studied at the National Taiwan University Hospital "involve[d] the cooperation and integration of the emergency, radiology, laboratory medicine, and neurology staff that conduct the initial assessment, imaging, and evaluation of acute ischemic stroke patients to expedite acute stroke treatment" (Chen et al., 2014, p. 2). In this protocol, the triage nurse contacted an ED physician in the critical care section if the nurse suspected a hyperacute stroke. If the physician initiated the Stroke Code protocol "the patient is triaged to the critical care section, and computer-based text messages are sent simultaneously to the duty radiologist, the consultant neurologist, the stroke nurse practitioner, and the on-call stroke attending staff" (Chen et al., 2014, p. 2).

At a South Korean hospital, a regional comprehensive stroke center, researchers studied the effects of prehospital notification to reduce the treatment time of acute stroke (Kim et al., 2016).

> [I]f a patient had at least one stroke warning sign by American Heart Association Stroke Council criteria, ER doctors or nurses activated the Stroke Code program, thereby initiating a predetermined set of events and recruiting the stroke team, which included neurologist, neurosurgeons, and an interventional neuroradiologist, by both a text message on their mobile phones and a broadcasting system. (p. 1666)

Once the Stroke Code was activated by an ER doctor or nurse, the patient's information was sent to other medical providers who would have direct contact with the patient (laboratories, radiology, and pharmacy) (Kim et al., 2016, p. 1666).

The OHS Stroke Code studied by Husseini and Goldstein (2013) involved patients impacted by a stroke who were "rapidly assessed by an ED nurse, and if stroke [was] suspected, an ED physician immediately perform[ed] an initial evaluation" (Husseini & Goldstein, 2013, p. 346). Once the Stroke Code is activated, a notification is sent to "responding neurologist, a pharmacist, and a nursing administrator" (Husseini & Goldstein, 2013, p. 346). In Puolakka, Strbian, Harve, Kuisma, and Lindsberg (2016) study, the medical providers included in the Stroke Code were both those involved with the patient prior to hospital arrival (regional emergency medical communication center and paramedics) and medical providers in the hospital (ED physician, hospital stroke neurologist, and nursing staff). The Sattin et al. (2006) study included the ED Physician, stroke team physician, pharmacist, nurses, and a radiologist (pp. 2935-2939).

Lab Values

Lab values are also an important component of the Stroke Code process. Laboratory values must be verified to assure that the patient meets the qualifications for IV-tPA administration and to rule out that a high or low glucose is mimicking stroke-like symptoms. In the Stroke Code studied by Chen et al. (2014)

> the emergency department (ED) nurse [performed] emergency blood tests, including blood glucose measurements . . . . A special mark [was] attached to the tube containing the blood sample for priority examination in the laboratory, particularly with respect to determination of the prothrombin time/international normalized ratio (INR). Because an

> INR <1.7 is a prerequisite for IV-tPA administration, a target door-to-INR time of ≤ 60 min is set into the protocol. (p. 3)

Vera et al. (2010) studied different lab analyses because their research focused on In Hospital Stroke (IHS). The researchers indicated that during a suspected IHS that "complete haematological and biochemical tests . . . were performed in all patients" (Vera et al., 2010, p. 171). Values consistently recorded throughout their study were "age, gender . . . blood pressure, temperature, and glycemia" (Vera et al., 2010, p. 171). Vera et al. (2010) noted that IV-tPA was not administered if INR was ≤ 1.7, indicating that INR was indeed included in the blood test that was collected.

Puoloakka, Strbain, Harve, Kuisma, and Lindsberg (2016) focused their study on the prehospital care of individuals believed to be affected by stroke. The ambulance crew measured "blood pressure, oxygen saturation, tympanic temperature, and blood glucose" (Puloakka et al., 2016, p. 3). The researchers reported "the key to short door-to-needle times is to do as little as possible after the patient has arrived at the ED and as much as possible before that" (Puloakka et al., 2016, p. 6).

Sattin el al. (2006) indicated that "the most important laboratory result we require before treatment is the serum glucose" (Sattin et al., 2006, p. 2936). The researchers also stated that paramedics may obtain a glucose level before arrival to the ED. The glucose level collected may be used until the chemistry panel is resulted and received by the physician or nurse. Another lab value that was collected was the platelet count. Sattin et al. (2006) explained that "the pivotal rt-PA study protocol also required a platelet count >100,000/μL" (p. 2936). Sattin et al. (2006) noted that treatment was not delayed until the results of the prothrombin time (PT) or partial thromboplastin time (PTT) were received unless there was a reason to believe that the results

would be abnormal and be a contraindication for tPA. Sattin et al. (2006) also did not require a stool guaiac blood tests to be performed before treatment (p. 2936).

Assessment Tools

In order to help determine if the patient has had a stroke, and there is a need to initiate a Stroke Code, certain evaluations will be performed. Assessment tools or evaluations that are used to look for signs of stroke include facial droop, slurred speech, and unilateral weakness. Some assessment tools, such as the Cincinnati Prehospital Stroke Scale are used to determine if there is a likelihood that a patient is impacted by an acute stroke, and others, such as the National Institutes of Health Stroke Scale are used to assess the severity of a stroke. Some of the studies used single or multiple assessment tools to evaluate patients. Hacke et al. (2008) researched multiple assessment tools in their study. During initial assessment, along with CT or MRI, "the National Institutes of Health Stroke Scale (NIHSS), a 15-item scale that measures the level of neurologic impairment" (p. 1320) was performed. They used other assessment tools later in their study including a modified Rankin Scale (to determine disability), the Barthel Index (to assess the patient's ability to perform daily activities), and the Glasgow Outcome Scale (to assess the patient's level of disability) (Hacke et al., 2008). While the NIHSS was used initially during the Stroke Code and the modified Rankin and Barthel Index were used after stroke treatment, each assessment tool gives valuable information on the patient's progress during an acute stroke.

Puolakka et al. (2016) concentrated on prehospital variants that could have an effect on treatment time for an acute stroke. "For acute stroke, the dispatcher screens for symptoms according to the BE FAST (balance, eyes, face, arm, speech, time) algorithm and some common stroke associated complaints to make the dispatch decision" (Puolakka et al., 2016, p. 2). Based

on the results of the FAST assessment, the patient would be considered "high priority" which would prompt an ambulance to be sent to their location immediately.

The prehospital Stroke Code Kim et al. (2016) evaluated used the "Cincinnati Prehospital Stroke Scale for early detection and transport of stroke patients" (p. 1666). The Cincinnati Prehospital Stroke Scale (CPSS) is an assessment tool used to evaluate facial droop, arm drift, and speech for determination of stroke. Kothari, Pancioli, Liu, Brott, and Broderick (1999) assessed the effectiveness of the CPSS when performed by prehospital providers. The researchers concluded that the "CPSS was easily taught, was reproducible, and was a valid tool when performed by paramedics and EMTs in identifying stroke patients who may be candidates for thrombolysis" (Kothari et al., 1999, p. 376).

Frendl, Strauss, Underhill, and Goldstein (2009) compared patients identified retrospectively from paramedic records who experienced a stroke/transient ischemic attack (TIA) with those of the hospital's prospective stroke registry for the year before and after training paramedics in the use of the Cincinnati Prehospital Stroke Scale (p. 754). Unlike Kim et al. (2016) and Kothari et al. (1999), they found that "simple EMS training in the CPSS, or its use, had no impact on paramedic's stroke/TIA identification accuracy" (p. 756). Friendl et al. (2009) determined:

> 70% of patients with a final diagnosis of stroke had at least one documented CPSS abnormality. Of patients presenting with a CPSS abnormality, however, less than half had a final diagnosis of stroke or TIA, reflecting the low specificity of the scale as used in the field. (p. 756)

The golden assessment tool when dealing with patients who experienced an acute stroke is the National Institutes of Health Stroke Scale (NIHSS). Josephson, Hills, and Claiborne

Johnston (2006) stated that "the NIH Stroke Scale is widely used in stroke clinical care" (p. 389). Multiple researchers used the NIHSS in the Stroke Code studies, both outside-of-hospital and in-hospital stroke (Chen et al., 2014, Hacke et al., 2008, Husseini and Goldstein, 2013, Josephson, Hills, & Claiborne Johnston, 2006, Kothari et al., 1999, Sattin et al., 2006, Tai et al., 2012, and Vera et al., 2010,).

Additional Information Regarding Stroke Code

Stroke Codes do have limitations on their effectiveness of diagnosing stroke. Tai et al. (2011) stated that "patients who presented outside business hours had longer door-to-needle time, CT-to-treatment time and onset-to-treatment time" (p. 1318). Outside of business hours include late at night, weekends, and holidays. While most Stroke Codes are performed 24 hours a day, seven days a week, some health care providers integrated in this protocol may not be present at the hospital and information must be relayed outside of the hospital.

"Despite increased public recognition and promotion in health campaigns, IV-tPA usage among all acute ischemic stroke patients has remained disappointingly low, with reported rates of 3% to 10% in Europe and North America and only 1.5% in Taiwan (Chen et al., 2014, p. 1). This number can be contributed to the fact that IV-tPA is therapeutic in a window of 4.5 hours.

"Altered mental status was the sole presenting symptom in 48% of the hospitalized patients, compared with only 10% of ED patients, and was the only clinical feature independently associated with a stroke mimic in the hospitalized patients" (Husseini & Goldstein, 2013, p. 345). While altered mental status could be a symptom of a stroke, it could also be a symptom of disease processes. This could be a factor that helps health care providers understand why the thrombolysis with in-hospital strokes is at a lower rate than those presenting to the ED. Hussieni and Goldstein (2013) argued that "developing a standardized assessment

protocol for hospitalized patients with altered mental status may improve the efficacy of care" (p. 345).

Yoo et al. (2016) stated that "the actual number of in-hospital-stroke patients who are candidates for reperfusion therapy is relatively low" (p. 661). The reasoning for this can be of a last known well time that is outside of the therapeutic window for thrombolysis or contraindications of the patient's disease process they are being treated for in the hospital. However, Yoo et al. (2016) claimed that "the findings of the present study suggest that the in-hospital code stroke program should be implemented in the entire hospital" (p. 661). A system wide implementation of Stroke Code will be able to help treat more patients impacted by stroke.

Puolakka et al. (2016) determined:

> the prehospital time intervals revealed that prompt operation on the scene and use of high-priority transport were key operational success features routing patients to the early categories of hospital arrival and recanalization treatment. Still, the delayed activation of the EMS remains the dominant holdup in the stroke chain of survival. (p. 5)

Therefore, time is of the utmost importance in the prehospital phase of stroke care. Prioritizing patients that may be experiencing a stroke allows a decrease in time to transport the patient to the hospital, thus improving the chances that the patient will potentially be able to successfully begin treatment for a stroke.

Conclusion

A Stroke Code is a notification to multiple health care providers to inform them that a patient may have had a stroke. Chen et al. (2014) found that a Stroke Code can reduce door-to-needle times and improve the rate IV-tPA is used. In fact, he reported that a Stroke Code can greatly increase the rate where patients receive IV-tPA in less than 60 minutes.

A crucial step in a Stroke Code is correct and prompt imaging to confirm that a stroke has indeed occurred. Researchers concluded that either a non-contrast CT or MRI are both acceptable scans to identify stroke.

Stroke Codes include a collective group of multidisciplinary providers. Chen et al. (2014) described a Stroke Code may involve many different health care providers. Puolakka, Strbian, Harve, Kuisma, and Lindsberg (2016) also included providers in Stroke Code prior to hospital arrival, such as regional medical communication center and paramedics. The collective goal of providers, whether before or after hospital arrival, are to decrease the overall DTN times.

Lab test are used during a Stroke Code in order to determine possible causes for stroke-like-symptoms and to evaluate if there are contraindications to delivering IV – tPA. High or low glucose levels may mimic stroke-like-symptoms (Chen et al., 2014). All researchers agreed that serum glucose levels are important to check during a Stroke Code (Chen et al., 2014, Vera et al., 2010, Puloakka et al., 2016, and Sattin el al., 2006). Vera el al. (2010) indicated that "complete haematological and biochemical test" should be performed during In Hospital Stroke Codes (p. 171).

Assessment tools are used in Stroke Codes to determine if there is a likelihood that a patient is suffering an acute stroke, and others are used to assess the severity of a stroke. Kim et al. (2016) discussed the Cincinnati Prehospital Stroke Scale (CPSS) for prehospital Stroke Codes. Other researchers agreed that the CPSS was an easy to learn assessment tool for EMS providers that had accurate outcomes (Kothari, Pancioli, Liu, Brott, and Broderick, 1999). Hacke et al. (2008) used the National Institutes of Health Stroke Scale (NIHSS) in his study when determining the severity of stroke. Other researchers agreed that the NIHSS is the golden

assessment tool and should be used in stroke scenarios (Josepheson, Hills, and Claiborne Johnston, 2006, p. 389).

CHAPTER 3

METHODS

The purpose of this study was to determine if the initiation of a Stroke Code in an acute care hospital reduces the door-to-needle time for patients affected by a stroke. The study also sought to determine which protocols within the Stroke Code process may be effective and which may be ineffective in decreasing the time from diagnosis to treatment. A retrospective non-experimental, quantitative design was selected for this study.

An objectives-oriented approach was used to determine if the initiation of a Stroke Code reduces door-to-needle time. In this study, the objective is defined as determining if a Stroke Code impacts the mean door-to-needle time for patients experiencing a stroke. When evaluating the overall process of the Stroke Code, the program objective can be deemed effective if the series of protocols did in fact reduce the mean door-to-needle time for patients diagnosed with a stroke.

Research Questions and Null Hypotheses

The following research questions and null hypotheses guided the study:

Research Question 1: Is there a significant difference in the time it took the physician to complete an evaluation between the pre- and post-Stroke Code periods?

HO1: There is no significant difference in the time it took the physician to complete an evaluation between the pre- and post-Stroke Code periods.

Research Question 2: Is there a significant difference in the times from patient arrival to receiving radiology report on patients between the pre- and post-Stroke Code periods?

HO2: There is no significant difference in the times from patient arrival to receiving radiology report on patients between the pre-and post-Stroke Codes.

Research Question 3: Is there a significant difference in the times for completing EKGs on patients between the pre- and post-Stroke Code periods?

HO3: There is no significant difference in the times for completing EKGs on patients between the pre- and post-Stroke Code periods.

Research Question 4: Is there a significant difference in the time to receive lab results between the pre- and post-Stroke Code periods?

HO4: There is no significant difference in the time to receive lab results between the pre- and post-Stroke Code periods.

Research Question 5: Is there a significant difference in the door-to-needle times between the pre- and post-Stroke Code periods?

HO5: There is no significant difference in the door-to-needle times between the pre- and post-Stroke Code periods.

Population

The population for the study was patients at an acute care hospital in northeast Tennessee who experienced stroke symptoms. The population was treated at Holston Valley Medical Center, a 590-bed acute care facility that includes critical care and Level 1 Trauma Center services located in Kingsport, Tennessee. HVMC is a member of the 21 hospital Ballad Health system that serves 29 counties in the northeast Tennessee, southwest Virginia, northwest North Carolina, and southeast Kentucky area.

The population for this study was 362 patients who presented to the Emergency Department at Holston Valley Medical Center between April 1, 2014 and December 31, 2016.

During this pre-Stroke Code period (April 1, 2014 to December 31, 2014) 21 patients were administered IV-tPA. A second population group included 341 patients presenting to the Emergency Department from September 1, 2015 to December 31, 2016. Of that group, 69 patients were administered IV-tPA between September 1, 2015 and December 31, 2016 (after the Stroke Code was initiated).

Informed Consent

Although the patient information is confidential no patient identifiers were collected as a part of this study. This was a retrospective chart review and consent was not required.

Data Collection Procedures

Times and data collected for pre- and post-Stroke Code patients were extracted upon reviewing health care providers' charting by the Holston Valley Medical Center Stroke Coordinator and manually entered into an Excel spread sheet. Only data pertaining to the process of stroke diagnoses and tPA administration were included in this study. The times were pertinent information in the process of diagnosing a stroke and the time tPA was administered. The data collected were: the time of patient arrival to the Emergency Department, the time the Emergency Department physician assessed the patient, the time it took the patient from arrival to Emergency Department physician assessment, the time CT scan was ordered, the time CT scan was resulted, the time a chest x-ray was ordered, the time the chest x-ray was resulted, the time it took from patient arrival to radiology imaging resulted, the time complete blood count (CBC), basic metabolic panel (BMP), and PT/INR were ordered, the time CBC, BMP, and PT/INR were resulted, the time an EKG was ordered, the time the EKG was completed, the time from patient arrival to completion of EKG, the time IV tPA was ordered, the time IV tPA was initiated, and the time from patient arrival to initiation of IV tPA.

Data Analysis Procedures

The data were analyzed using IBMs Statistical Package for the Social Sciences (SPSS) Version 25. Descriptive statistics and independent samples *t*-tests were used to evaluate data in an effort to answer the study's research questions. A 95% confidence level was selected for the study (alpha < 0.05).

Independent samples *t*-tests were used to assess the null hypotheses for Research Questions 1 - 6. SPSS was used to calculate means, standard deviations, and *f* values for items related to MD evaluation, completing imaging procedures, completing EKGs, receiving lab results, interpreting CT images, and door-to-needle times in pre and post-Stroke Code periods. Therefore, the initiation of a Stroke Code was evaluated to determine if it is a viable option in acute care settings to reduce diagnostic times to prepare the patient for treatment.

CHAPTER 4

FINDINGS

"Acute stroke care implemented with "Stroke Code" (SC) or similar strategies is reported in several studies to enhance IV-tPA administration and reduce door-to-needle (DTN) time" (Chen et al., 2014, p.1). The purpose of this study was to determine if the initiation of a Stroke Code in an acute care hospital reduced the door-to-needle time for patients affected by a stroke. The study also sought to determine which protocols within the Stroke Code process were effective and which, if any, ineffective in decreasing the time from diagnosis to treatment. Times and data collected for pre-Stroke Code patients were extracted upon reviewing health care providers' charting by the Holston Valley Medical Center Stroke Coordinator and manually entered into an Excel spread sheet. Only data pertaining to the process of stroke diagnoses and tPA administration were included in this study. The times were pertinent information in the process of diagnosing a stroke and the time tPA was administered.

"Code stroke was implemented at the Royal Melbournce Hospital (RMH) in July 2007 and involves emergency triage, assessment by an emergency physician, ordering of investigations and prompt referral to the stoke team. . ." (Tai et al., 2012, p. 1316). In order to conduct this study, four different aspects of a Stroke Code were included and their impact on the door-to-needle times before and after implementation of a Stroke Code was evaluated. The last item evaluated in this study was the global measure of effectiveness, the difference between the door-to-needle times before and after a Stroke Code was used.

I analyzed times that were collected at different moments during the process of diagnosing and treating stroke during the time periods prior to Stroke-Code implementation and after Stroke-Code implementation and the following questions guided this study:

Question 1: Is there a significant difference in the time from patient arrival to physician assessment between pre- and post-Stroke Code periods

Question 2: Is there a significant difference in the times from patient arrival to receiving radiology reports on patients between the pre- and post-Stroke Code periods?

Question 3: Is there a significant difference in times of patient arrival to receiving lab results between the pre- and post-Stroke Codes?

Question 4: Is there a significant difference in times of patient arrival to completing an EKG on patients during designated pre- and post-Stroke Code periods?

Question 5: Is there a significant difference in the door-to-needle times between pre- and post-Stroke Code periods?

Population

The population of the study was 703 patients at an acute care hospital in northeast Tennessee who experienced stroke symptoms. The patients were treated at Holston Valley Medical Center (HVMC) in Kingsport Tennessee, a 590-bed acute care facility that includes critical care and at the time of the study included Level 1 Trauma Center services. HVMC is a member of the 21 hospital Ballad Health system that serves 29 counties in the northeast Tennessee, southwest Virginia, northwest North Carolina, and southeast Kentucky area.

The population for this study included two groups. The first group was 362 patients who presented to the Emergency Department at Holston Valley Medical Center between April 1, 2014 and December 31, 2016. During this pre-Stroke Code period (April 1, 2014 to December 31, 2014) 21 patients were administered IV-tPA. The second group included 341 patients presenting to the Emergency Department from September 1, 2015 to December 31, 2016. Of

that group, 69 patients were administered IV-tPA between September 1, 2015 and December 31, 2016 (after the Stroke Code was initiated).

Analysis of the Data

Research Question 1: Physician Assessment

Research question 1 was stated as follows: Is there a significant difference in the time from patient arrival to physician assessment between pre- and post-Stroke Code periods? An independent samples *t* test was used to determine if there was a significant difference in times related to physician assessment pre and post stroke code implementation. At a 95% confidence interval (alpha =.05) the results indicated a significant difference between the times, $t(19.317)=3.65$, $p<.01$. The mean time for physician assessment prior to the initiation of the stroke code protocol was 11.6 minutes and the mean time post implementation dropped to 4.3 minutes. The 95% confidence interval for the mean difference was wide and ranged between 3.13 and 11.55 minutes (Table 1).

Table 1

Time from Patient Arrival to Physician Assessment Between pre- and post-Stroke Code Periods

	Prior to Stroke Code	Post Stroke Code
N	19	317
Mean	11.63	4.29
Std. Deviation	8.269	6.302
Std. Error Mean	1.980	.354
t	4.817	3.649
df	334	19.168

(continued)

Sig. (2-tailed)	.000	.002
Mean Difference	7.388	7.338
Std. Error Difference	1.523	2.011

Research Question 2: Radiology Reports

Research question 2 was stated as follows: Is there a significant difference in the times from patient arrival to receiving radiology reports on patients between the pre- and post-Stroke Code periods? An independent samples t test was used to determine if there was a significant difference in times related to radiology arrival pre and post stroke code implementation. At a 95 % confidence interval (alpha =.05) the results indicated a significant difference between the times t (19.279)=3.93, p<.01. The mean time for patient arrival to receiving radiology results prior to the initiation of the stroke code protocol was 77.3 minutes and the mean time post implementation dropped to 26.5 minutes. The 95% confidence interval for the mean difference was wide and ranged between 23.65 and 77.93 minutes (Table 2).

Table 2

Times from Patient Arrival to Receiving Radiology Reports on Patients Between the pre- and post-Stroke Code Periods

	Prior to Stroke Code	Post Stroke Code
N	19	279
Mean	77.26	26.47
Std. Deviation	56.228	13.493
Std. Error Mean	12.899	.808
t	11.239	3.930

(continued)

df	296	18.141
Sig. (2-tailed)	.000	.001
Mean Difference	50.790	50.790
Std. Error Difference	4.519	12.925

Research Question 3: Lab Results

Research question 3 was stated as follows: Is there a significant difference in times of patient arrival to receiving lab results between the pre- and post-Stroke Codes? An independent samples *t* test was used to determine if there was a significant difference in times related to receipt of laboratory results pre and post stroke code implementation. At a 95% confidence interval (alpha =.05) the results indicated a significant difference between the times *t* (21.286)=3.74, $p<.01$. The mean time for receipt of laboratory results prior to the initiation of the stroke code protocol was 74.2 minutes and the mean time post implementation dropped to 43.0 minutes. The 95% confidence interval for the mean difference was wide and ranged between 13.86 and 48.73 minutes (Table 3).

Table 3

Times of Patient Arrival to Receiving Lab Results Between the pre- and post-Stroke Code

	Prior to Stroke Code	Post Stroke Code
N	21	286
Mean	74.24	42.95
Std. Deviation	38.098	16.839
Std. Error Mean	8.314	.996
t	7.293	3.737

(continued)

df	305	20.578
Sig. (2-tailed)	.000	.001
Mean Difference	31.291	31.291
Std. Error Difference	4.291	8.373

Research Question 4: Completing an EKG

Research question 4 was stated as follows: Is there a significant difference in times of patient arrival to completing an EKG on patients during designated pre- and post-Stroke Code periods? An independent samples *t* test was used to determine if there was a significant difference in times related to arrival to EKG pre and post stroke code implementation. At a 95% confidence interval (alpha =.05) the results did not indicate a significant difference between the times t (21.275)=-1.61, p=.18. The mean time for arrival to EKG prior to the initiation of the stroke code protocol was 29.90 minutes and the mean time post implementation rose to 39.51 minutes. The 95% confidence interval for the mean difference was wide and ranged between 2.46 and -21.66 minutes (Table 4).

Table 4

Times of Patient Arrival to Completing an EKG on Patients During Designated pre- and post-Stroke Code Periods

	Prior to Stroke Code	Post Stroke Code
N	21	275
Mean	29.90	39.51
Std. Deviation	26.372	27.116

(continued)

Std. Error Mean	5.755	1.635
t	-1.567	-1.605
df	294	23.349
Sig. (2-tailed)	.118	.122
Mean Difference	-9.604	-9.604
Std. Error Difference	6.128	5.983

Research Question 5: Door-to-Needle Times

Research question 5 was stated as follows: Is there a significant difference in the door-to-needle times between pre-and post-Stroke Code periods? An independent samples *t* test was used to determine if there was a significant difference in times related to tPA administration pre and post stroke code implementation. At a 95 % confidence interval (alpha =.05) the results indicated a significant difference between the times t (20.67)=4.16, p<.01. The mean time for tPA administration prior to the initiation of the stroke code protocol was 98 minutes and the mean time post implementation dropped to 62.6 minutes. The 95% confidence interval for the mean difference was wide and ranged between 17.8 and 52.8 minutes (Table 5).

Table 5

Door-to-Needle Times Between pre- and post-Stroke Code Periods

	Prior to Stroke Code	Post Stroke Code
N	20	67
Mean	97.95	62.63
Std. Deviation	35.787	23.176

(continued)

Std. Error Mean	8.002	2.831
t	5.227	4.161
df	85	23.947
Sig. (2-tailed)	.000	.000
Mean Difference	35.323	35.323
Std. Error Difference	6.757	8.488

Summary

This study found that there were decreases and increases in the times of different time frames involved in treating patients with a stroke pre- and post-Stroke Code. The physician assessment times were found to significantly decrease from a mean of 11.63 minutes to 4.29 minutes ($p<.01$) after the implementation of a Stroke Code. The radiology result times were found to significantly decrease from a mean of 77.26 minutes to 26.47 minutes ($p<.01$) after the implementation of a Stroke Code. The receiving of lab results were found to significantly decrease from a mean of 74.24 minutes to 42.95 minutes ($p<.01$) after the implementation of a Stroke Code. The overall door-to-needle times were found to significantly decrease from a mean of 97.25 minutes to 62.63 minutes ($p<.01$) after the implementation of a Stroke Code. However, the time from arrival to EKG results were found to significantly increase from 29.90 minutes to 39.51 minutes ($p<.18$) after the implementation of a Stroke Code.

CHAPTER 5

CONCLUSIONS, DISSCUSSION, AND RECOMMENDATIONS

The focus of this study was to determine if the implementation of a Stoke Code in an Emergency Department would affect the times of diagnostic procedures and have an impact on the overall door-to-needle times. Different times were analyzed from the patient's arrival until physician assessment, receiving radiological reports, lab results were received and when an EKG was completed. Specifically, the door-to-needle times were studied to see if IV-tPA administration times were affected by following a Stroke Code's protocols.

Conclusions

Conclusions were based on the analysis of data collected from an Emergency Department implementing Stroke Code protocols in an effort to reduce door-to-needle times for tPA administration. Different organizations may conduct Stroke Code policy and procedure in a different manner, this study evaluated the processes at a single institution. However, the purpose of a Stroke Code is to reduce the door-to-needle times for patients being medically treated for an acute stroke. The study evaluated the following segments of the overall process and found:

1. The time from patient arrival until physician assessment were decreased after a Stroke Code was implemented.
2. The time from patient arrival until radiological results were received decreased after a Stroke Code was implemented.
3. The time from patient arrival until lab results were received decreased after a Stroke Code was implemented.
4. The time from patient arrival until an EKG was completed increased after a Stroke was implemented.

5. The door-to-needle times were decreased once a Stroke Code was implemented.

Discussion

The collective idea of a Stroke Code is to reduce the overall door-to-needle times. This decreases the time before treatment initiation for patients being affected by acute stroke. In order to determine if IV-tPA should be administered, several diagnostic test must be performed in order to diagnose a stroke. Reducing the times of diagnostic testing should reduce overall door-to-needle times and the results of this study showed that. Being able to reduce the times can be altered by using a pre-determined protocol set in place once a stroke is suspected.

In the population studied, pre-assessment tools were used by Emergency Medical Services in order to alert the Emergency Department that a suspected stroke was in route. This allows the Emergency Department physician to meet Emergency Medical Services upon patient's arrival and to perform an initial patient assessment. Prior to Stroke Code, the physician would assess the patient with no pre-notification system in place.

Since the ED physician was present upon patient arrival, he/she was able to order radiological imaging and have the patient sent directly to the CT imaging suite. The radiology department ensured that the Stroke Code patient was priority and they were immediately placed on the diagnostic table to receive imaging procedures. Prior to Stroke Code, the patient was placed in queue to be the next available patient that would have the imaging procedure.

Laboratory staff was also notified of the activation of a Stroke Code. Laboratory staff was present at bed side to draw blood for laboratory testing while the physician was performing initial assessments and to physically transport the samples to the laboratory where testing would be completed with results inputted to the Laboratory Information System that was interfaced to

the patient's medical records. Prior to Stroke Code, the patient was placed in queue to where blood samples would be tested, and results were inputted into the patient's medical records.

Prior to Stroke Code, EKGs were performed on patients if the Emergency Department physician ordered them on patients suspected of stroke. EKGs were resulted by the Emergency Department physician in a queue system in order of patient priority. After the Stroke Code was implemented, Emergency Medical Services performed an EKG before the patient arrived at the Emergency Department. The EKG was available for the physician to interpret before the patient arrived. Another EKG was performed after the patient's arrival at the discretion of the physician. It is assumed that having a second EKG after the patient's arrival was not prioritized in the data present in the pre-Stroke Code data. This could have resulted in the increase in time of EKG completion in the post-Stroke Code result with a mean of 29.90 minutes in the pre-Stroke Code data and a mean of 39.51 minutes in the post-Stroke Code data (Table 4).

IV-tPA was administered based on physician discretion once diagnostic stroke tests were completed. The study did not conduct research of the success of IV-tPA treating stroke or to determine anything beyond the time when IV-tPA was administered to the patient. Times before and after Stroke Code implementation were analyzed to evaluate the difference in door-to-needle times.

This study shows similar results regarding door-to-needle times that other studies, referenced in this research, resulted. Sattin et al., (2006) discuss "expedited code stroke protocol avoids delays for test that we believe contribute little to the evaluations of the patient's suitability for thrombolysis. . ." (p. 2938). Having protocols to eliminate delays between diagnostic test decreases the time to administer IV-tPA. Chen et al., (2014) found a correlation between door-to-CT time and median DTN time. The researchers found median door-to-CT time in the pre-

Stroke Code era to be 24 minutes and reducing to 11 minutes in the Stroke Code era. They also found median door-to-needle time to be 88 minutes in the pre-Stroke Code era and reducing to 41 minutes in the Stroke Code era, a 37-minute (54%) reduction in time (Chen et al., 2014, p. 5). This confirms that reducing time to perform diagnostic testing has a correlation with reducing door-to-needle times.

Recommendations for Further Study

Further research could answer the following questions:

1. Are Stroke Codes more productive over time? Is there a difference in door-to-needle times after one year versus five years of implementation of Stroke Code? Organizations could use these results to determine if adjustments need to be made in order to achieve their targeted door-to-needle times.
2. What protocols in Stroke Codes are most affective in decreasing door-to-needle times? Understanding which protocols reduce door-to-needle times the most could allow protocols to be altered to lessen overall door-to-needle times.
3. How does this study's results compare to similar studies? Comparing other researchers' results could substantiate the validity of this study's findings.

REFERENCES

Advani, R., Naess, H., & Kurz, M. (2017). The golden hour of acute ischemic stroke. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 25*(54), 1-5. doi:10.1186/s13049-017-0398-5

Benavente, L., Villanueva, M.J., Vega, P., Casado, I., Vidal, J. A., Castano, B., … Calleja, S. (2016). Code stroke in asturias. *Neurologia, 31*(3), 143-148. doi: 10.1016/j.nrleng.2015.07.007

Chalela, J. A, Kidwell, C. S., Nentwich, L. M., Luby, M., Butman, J. A., Demchuk, A. M., … Warach, S. (2007). Magnetic resonance imaging and computed tomography in emergency assessment of patients with suspected acute stroke: a prospective comparison. *The Lancet, 369*(9588), 293-298. doi:10.1016/S0140-6736(07)60151-2

Chen, C., Tang, S., Tsai, L., Hsieh, M., Yeh, S., Huang, K., Jeng, J. (2014). Stroke code improves intravenous thrombolysis administration in acute ischemic stroke. *PLOS ONE, 9*(8), 1-8. doi:10.1371/journal.pone.0104862

Friendl, D. M., Strauss, D. G., Underhill, K. K., Goldstein, L. B. (2009). Lack of impact of paramedic training and use of the Cincinnati prehospital stroke scale on stroke patient identification and on-scene time. *Stroke, 40*(3), 754-756. doi:10.1161/STROKEAHA.108.531285

Hacke, W, Kaste, M., Bluhmki, E., Brozman, M., Davalos, A., Guidetti, D., … Toni, D. (2008) Thrombolysis with alteplase 3 to 4.5 hours after acute ischemic stroke. *The New England Journal of Medicine, 359*(13), 1317-1329. doi:10.1056/NEJMoa0804656

Husseini, N., & Goldstein, L. (2013). "Code stroke": Hospitalized versus emergency department patients. *Journal of Stroke and Cerebrovascular Diseases, 22*(4), 345-348.

doi:10.1016/j.jstrokecerebrovasdis.2011.09.012

Josephson, A. S., Hills, N. K., & Claiborne Johnston, S. (2006). NIH stroke scale reliability in ratings from a large sample of clinicians. *Cerebrovascular Diseases, 22,* 389-395. doi:10.1159/000094857

Kim, D., Nah, H., Park, H., Choi, J., Kang, M., Huh, J., & Cha, J. (2016). Impact of prehospital intervention on delay time to thrombolytic therapy in a stroke center with systemized stroke code programs. *Journal of Stroke and Cerebrovascular Diseases, 25*(7), 1665-1670. doi:10.1016/j.jstrokecerebrovasdis.2016.02.011

Kothari, R. U., Pancioli, A., Liu, T., Brott, T., & Broderick, J. (1999). Cincinnati prehospital stroke scale: Reproducibility and validity. *Annals of Emergency Medicine, 33*(4), 373-378. doi:10.1016/S0196-0644(99)70299-4

Puolakka, T., Strbain, D., Harve, M., Kuisma, & Lindsberg, P. (2016). Prehospital phase of the stroke chain of survival: A prospective observational study. *Journal of the American Heart Association, 5*(5). doi:10.1161/JAHA.115.002808

Sattin, J., Olson, S. E., Liu, L., Raman, R., & Lyden, P. (2006). An expedited code stroke protocol is feasible and safe, 37(12), 2935-2939. doi: 10.1161/01.str.0000249057.44420.4b

Tai, Y. J., Weir, L., Hand, P., Davis, S., & Yan, B. (2012). Does a 'code stroke' rapid access protocol decrease door-to-needle time for thrombolysis? *Internal Medicine Journal, 42*(12), 1316-1324. doi:10.1111/j.1445-5994.2011.02709.x

Vera, R., Lago, A., Fuentes, B., Gallego, J., Tejada, I., Casoda, I., … Masjuan, J. (2010) In-hospital stroke: A multi-centre prospective registry. *European Journal of Neurology, 18*(1), 170-176. doi:10.1111/j.1468-1331.2010.03105.x

Wintermark, M., Albers, G., Alexandrov, A., Alger, J., Bammer, R., Baron, J., … Warach, S. (2008). Acute stroke imaging research roadmap. *Stroke, 39*(5), 1621-1628. doi: 10.1161/STROKEAHA.107.512319

Wojner, A., Morgenstern, L., Alexandro A., Rodriguez, D., Pressed, D., Grotto, J. (2003). Paramedic and emergency department care of stroke: baseline data from a citywide performance improvement study. *American Journal of Critical Care, 12*(5), 411. Retrieved from http://ajcc.aacnjournals.org/content/12/5/411.full.pdf+html

Yoo, J. Song, D., Baek, J. H., Lee, K., Jung, Y., Cho, H. J., … Heo, J. H. (2016). Comprehensive code stroke program to reduce repercussion delay for in-hospital stroke patients. *International Journal of Stroke, 11*(6), 656-662. doi:10.1177/1747493016641724

VITA

JESSE OSBORNE

Education:	Bachelor of Science in Allied Health, concentration Cardiopulmonary Science, East Tennessee State University, Johnson City, Tennessee, 2010
	Master of Science in Allied Health, East Tennessee State University, Johnson City, Tennessee, 2020
Professional Experience:	Registered Respiratory Therapist, Kingsport, Tennessee, 2010-present