Workflow of Stroke Patients Arriving by Personal Vehicle

Capstone: Evidenced Based Practice Project

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By

Bethany Costello, BSN, RN, CCRN

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Abstract

Introduction: Stroke is a prevalent acute illness in our society that can cause life-long debilitating deficits and in some cases can be fatal. The administration of recumbent tissue plasminogen activator, also known as Alteplase, is associated with better long-term outcomes, lower mortality rates, and decreased deficits when given rapidly following diagnosis. We aim to decrease the time from patient arrival to Alteplase administration in a small, rural emergency department in Pennsylvania by identifying delays and creating a workflow allowing for seamless identification and treatment of acute ischemic stroke. **Methods:** Areas of delays were identified following in-unit observation and an extensive literature search. An improved workflow was created and implemented along with a standing order set allowing the patient to obtain CT scan prior to being placed in a room. **Findings:** On a single patient walk through of the revised workflow the door to stroke alert time, door to CT scan time, and door to Patronus Neurology tele-consult times were all decreased from the previous quarter's average. **Discussion:** Through implementation of a nurse-driven stroke alert protocol the triage nurse was empowered to identify a stroke, call a level one stroke alert, and facilitate the CT scan process all independent of physician guidance. **Implications:** By reducing these time spans and receiving Alteplase administration in a timely fashion, patients will appreciate better long-term outcomes and fewer deficits.

Key Words: stroke, alteplase, tPA, ischemic, thrombolytic, door-to-needle, DNT, CT scan, workflow, standing order set

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CHAPTER 1.

Workflow of Stroke Patients Arriving by Personal Vehicle

Every 40 seconds someone in the United States sustains a stroke, and every four minutes an individual dies from this stroke (Rhew et al., 2017). With statistics as staggering as these, stroke effects each of us in one way or another, whether it be ourselves or a loved one that succumbs to a stroke. There are national efforts to increase education about stroke symptoms, prevention, and treatment with an emphasis on how crucial of a factor time is. For each minute that a large-vessel occlusion, or ischemic stroke, goes untreated 1.9 billion neurons and 13.8 billion synapses are lost which in one hour is equivalent to the same loss that would occur in 3.6 years of the natural aging process (Speirs & Mitchell, 2015). The door-to-needle time (DNT) is the time that lapses between the time a patient arrives in the emergency department (ED) and the time that intravenous recombinant tissue plasminogen activator (tPA), otherwise known as the pharmaceutical drug Alteplase is administered. It is this metric that I hope to reduce in a small rural ED in Pennsylvania utilizing the framework of Kurt Lewin's change theory through the implementation of an improved workflow for patients arriving via personal vehicle with an acute ischemic stroke.

Clinical Practice Problem

A patient suffering from stroke or stroke-like symptoms who summons emergency medical services (EMS) gives themselves a slight advantage over those individuals who choose to be driven to the hospital via personal vehicle because the hospital staff is aware of their condition and estimated time of arrival and can be prepared to meet them at the door. At the community hospital studied in the microsystem assessment, the average time from door to

Alteplase administration over the past year was 54 minutes when arriving by private vehicle compared to 45 minutes when arriving via Emergency Medical Services (EMS) (Evangelical Community Hospital, 2020). While this is within the national standard of 60 minutes, the literature shows that there is a direct relational benefit to more rapid administration of Alteplase to within 30 minutes of arrival to achieve the best possible outcomes (Yang et al., 2014; Elder et al., 2015; Yoo et al., 2018; Min-Yi et al., 2019; Tran et al., 2019).

PICOT Statement

In patients with acute ischemic stroke symptoms arriving via personal vehicle to the emergency department, does the use of an improved stroke workflow and a standardized order set as opposed to the use of the current stroke workflow and no order set decrease the average time from door to Alteplase administration as measured in minutes?

Global Aim Statement

We aim to improve the average time from door to Alteplase administration in patients arriving with acute ischemic stroke symptoms via personal vehicle to the emergency department. The process begins with reconfiguring the workflow to allow the stroke alert to be activated within the triage bay allowing the patient to receive a CT scan prior to being placed in a room. The process ends with timely interpretation of radiologic scans and subsequent prompt administration of Alteplase to applicable patients. By working on the process, we expect decreased times from door to CT scan, decreased times from door to Alteplase administration, and thus higher incidents of patients surviving strokes with decreased lasting deficits. It is important to work on this now because the current process takes an average of 54 minutes and the emergency department has elected lowering this number as their 2020-2021 quality initiative.

Patient Population

Approximately 88% of all admitted patients enter this hospital through the emergency department as opposed to other routes such as direct admissions or transfers from other facilities according to the microsystem assessment completed. Of these patients, the majority (37.1%) were aged 76 years or older with the next closest (25.9%) aged 66 to 75 years, meaning the patient population is primarily composed of the elderly. The gender comparison was close, yielding 54% males to 46% females, and information regarding patients' living situation prior to presentation was unavailable. The most prevalent admitting diagnosis was sepsis with an unspecified source; cerebral infarction was not found until the seventh leading diagnosis on this list. The majority of patients (60%) are discharged to home while 18% are discharged to a skilled nursing facility and the remaining 22% are discharged to other locations.

Practice Environment

The emergency department at this small rural hospital contains 18 beds and 4 triage suites contained in an area known to staff as the pit. Currently, construction is underway in and around the ED to expand the hospital as a whole and provide more private rooms for admitted patients. This construction has been ongoing for over a year, and adds an extra level of stress and disorganization to staff that is worth mentioning and keeping in mind as we implement this project. The layout of the ED is thoughtfully done with the radiology department directly outside the doors to the unit which allows for easy access and transport of critical patients, namely those suspected of having a stroke. The unit as a whole is fast paced yet well organized and all staff seem to not only know their own roles but also how and when to assist colleagues to provide the best total care for the patients.

Strengths

Identified strengths within the emergency department which pertain directly to the workflow improvement implementation project are as follows:

1) Support from higher management
2) Pre-existence of a stroke alert protocol
3) Visibility of student within the unit and open communication about the project

The strengths leading into this project far outweigh the weaknesses. The support from management has been present from the initial project suggestion and with current stroke alert protocols already in place we are essentially taking a current process and offering opportunities to build and enhance upon it. I have been visible around the unit, have introduced myself to the majority of the staff I have worked alongside, and have been speaking to them about the upcoming project to not only get a feel for where they are desiring change, but to build excitement around the unit of the prospective improvements to come.

Weaknesses

Likewise, areas of weakness were identified within the emergency department which may serve as hinderances to successfully implementing this project. They are as follows:

1) Aversion to change shown by seasoned staff
2) Staff noncompliance with assigned tasks
3) Concurrent unit construction

The most difficult hurdle to overcome with this project implementation will be gaining staff's approval and desire to change, especially within the senior staff population. Those who

have been working on a unit for a length of time do not readily want a student coming in to change things without giving some push-back, and I anticipate that to be the case in a handful of individuals. Along the same line, staff have been historically noncompliant with things such as checking or responding to e-mails, completing surveys, or adhering to new documentation within the electronic health record. A simple incentive, such as a small food item or gift card raffle will need to be applied in order to gain staff participation in some areas, namely getting feedback and maintaining compliance with the change. Finally, as previously stated, the unit is currently surrounded by construction equipment and workers, which adds a slight feeling of disorganization that may cause staff to be less receptive to further change.

Interdisciplinary Communication

The layout of the emergency department allows for easy and open communication between nursing, physicians, nursing assistants, and all members of the patient care team. While interdisciplinary rounds are not completed as they are on inpatient units, all members of the patient care team are in constant communication about the patient's diagnosis, vital sign trends, and goals. They work together to develop a plan of care that is patient-specific, and they ensure that all members of the team are informed of the plan and their individual roles within it. The electronic health record helps to close the communication loop by compiling data entered by each of the various disciplines and making it readily viewable to all members of the care team. From the time I have spent thus far observing in the ED, there doesn't appear to be any issues with patronizing or looking down on another's role in the patient's care. Staff speak to one another as respected peers which is important to achieve the best possible patient outcomes.

Collaboration

The emergency room must collaborate externally with local EMS, local skilled nursing facilities, area police departments and internally with the radiology department, patient transport, and the inpatient units. These collaborations allow for seamless patient flow and avoid causing a back-up of patients waiting to depart to their next location. On the intake side, these three external agents transmit communications to the ED, alerting them of incoming patients, acuity, and estimated time of arrival. This notification allows ED staff to make available a room and any necessary staff or equipment needed to greet the patient. On the internal end of things, communication with the radiology department is critical for implementation of this project to allow suspected stroke patients faster door-to-CT scan times. Collaborating with patient transport and the inpatient units is crucial in such a small ED to optimize the turnover of rooms.

Chapter 2. LITERATURE REVIEW

Initial Literature Search

An extensive literature review was performed on the topic of acute ischemic stroke and alteplase administration. The Nursing & Allied Health Database was first utilized with a search of the key words ‘stroke’ and ‘alteplase’ - this yielded 2,698 results. The search limitations of ‘full text’ and ‘peer reviewed’ were applied as well as the date range limitation of 2014-present and only articles in the English language were filtered out which yielded 694 results. Repeat searches of the same database and with the same limitations were conducted with the following key words and result yields; ‘door-to-needle reduction’ 120 results, ‘stroke’ and ‘standing order’ 18 results, ‘stroke work flow’ and ‘alteplase’ 189 results and ‘alteplase delay’ 336 results.

The same five searches were then conducted using the Medline with Full Text database utilizing the same limitations as well as ‘age - all adults 19+ years.’ The initial search of ‘stroke’

and alteplase' yielded 224 results, subsequent findings were 'door-to-needle reduction' yielding zero results but 1,172 results based on key words, 'stoke' and 'standing order' yielding zero results and zero related search results, 'stroke work flow' and 'alteplase' yielding zero exact results but 70 results based on keywords, and 'alteplase delay' yielding zero exact results but 3 results based on keywords.

Given the surplus of articles gathered from these searches, the titles of each were reviewed for relevance to this improvement project and articles which contained an abstract were scoured with relevant data highlighted for further review. Once these were narrowed down to 25 articles, each were read thoroughly and 15 which were directly pertinent to this project were selected for inclusion. These final 15 were read through a second time with relevant data being gathered and compiled in an evidence matrix, see Appendix A.

Stroke Statistics

I would briefly like to review the statistics on stroke presented in the literature, as there are some discrepancies among the articles. Stroke is identified as the third leading cause of death by Rhew et al. (2017), however Elder et al. (2015) and Speirs & Mitchell (2015) identify stroke as the fourth leading cause of death in the United States. The implication of this inconsistency is that through the years, stroke prevalence has increased such that is has moved up from the fourth leading cause in 2015 to the third leading cause in 2017, meaning that there must be a focus today on more education about stroke and prevention measures.

Not surprisingly, the definition and/or cause of an acute ischemic stroke is evaluated in three studies (Elder et al., 2015; Zerna et al., 2018; Tran et al., 2019) and additional statistical

facts are presented in two articles (Speirs & Mitchell, 2015; Rhew et al., 2017). Please see the full evidence matrix, Appendix A, for further details.

Treatment of Acute Ischemic Stroke

Recombinant tissue plasminogen activator (tPA), otherwise known as the Food and Drug Administration (FDA) approved pharmacological intervention, Alteplase, was unanimously stated to be the primary standard treatment for acute ischemic stroke (Emberson et al., 2014; Yang et al., 2014; Elder et al., 2015; Speirs & Mitchell, 2015; Yoo et al., 2018; Zerna et al., 2018; Campbell et al., 2019; Tennyson et al., 2019; Tran et al., 2019; Jaffe et al., 2020; Kamal et al., 2020 Man et al., 2020). Zerna et al. (2018) and Min-Yi et al. (2019) go on to discuss the benefits of advancing to endovascular thrombectomy (EVT) for large vessel occlusion strokes in patients who are not Alteplase candidates. While EVT is a vital component of stroke treatment, it is not directly pertinent to the goal of this workflow improvement process, therefore, further information on this topic will not be discussed but can be viewed within the evidence matrix, Appendix A.

Exact timeframes in which Alteplase could or should be administered varied among the literature. Five articles claimed no specific time parameters, but noted that Alteplase should be given as rapidly as possible following initial symptom onset to achieve the best outcomes (Yang et al., 2014; Elder et al., 2015; Yoo et al., 2018; Min-Yi et al., 2019; Tran et al., 2019). Some articles note target DNTs as recommended by various organizations/initiatives such as the American Heart Association's goal of administration within 60 minutes (Speirs & Mitchell, 2015; Jaffe et al., 2020; Man et al., 2020), the US Target: Stroke Initiative's goal of administration within 45 minutes (Kamal et al., 2020) and an unnamed "framework for acute ischemic stroke therapeutics" target of 30 minutes or less (Zerna et al., 2018, p. 1254). Two

studies have corroborated the benefits of administering Alteplase within 4.5 hours of symptom onset or LKWT (Emberson et al., 2014; Tennyson et al., 2019) while Campbell et al. (2019) boasts that administration up to nine hours from stroke symptom onset or in those with wake-up stroke symptoms with salvageable brain tissue shown on imaging has shown improved functional outcomes. Emberson et al. (2014) and Zerna et al. (2018) discuss that Alteplase has only been approved or licensed by the FDA for administration within three hours of stroke symptom onset.

The time at which Alteplase reaches a neutral effect or has an inverse risks/benefits ratio has been controversial in this literature. Zerna et al. (2018) states that they have found no average benefit of Alteplase administration after 270 minutes, or 4.5 hours, from stoke symptom onset and feel that to be the time as which the medication approaches a neutral effect, as where Emberson et al. (2014) estimated the time at which Alteplase has no effect to be 6.3 hours. Although the general consensus is that faster administration of Alteplase is directly correlated to increased outcomes, Man et al. (2020) revealed that DTN within 30 minutes was not associated with even better outcomes than those who received it within 45 minutes. Interestingly, Emberson et al. (2014) found that neither age nor stroke severity modified the therapeutic effect of Alteplase.

Delving deeper into Alteplase administration, the research has shown that patients have been found to have better long-term functional outcomes as measured at three and six months by the Oxford Handicap Scale Outcome Assessment (Emberson et al., 2014) and by the Modified Rankin Scale (mRS) at three months, one year, and 1.5 years (Man et al., 2020). Two studies reviewed outcomes as altered by a 15-minute difference in DTN; Speirs & Mitchell (2015) studied found that for every 15-minute DTN reduction, the mortality rate decreased by 5% and

similarly yet reversely studied, Man et al. (2020) showed that for every 15-minute increase in DTN there was a direct correlation with higher all-cause mortality and all-cause readmission. An interesting postulation by Zerna et al. (2018) related to outcomes measurement is that the NIHSS score does not weigh deficits or disability equally and is therefore not an accurate depiction of stroke severity or stroke impact on quality of life.

Risk versus benefit of Alteplase administration was not as heavily discussed throughout the literature as one would assume given that it carries severe and potentially life-threatening side effects such as bleeding and subsequent intra-cranial hemorrhage (Genentech USA, 2020). Campbell et al. revealed that "the number of patients with symptomatic intracerebral hemorrhage was significantly higher in the alteplase group than the placebo group [...] however, no significant differences were identified in mortality" (2019, p. 143). Emberson et al. (2014) found that the proportional increase in risk of fatal intracranial hemorrhage was the same regardless of treatment delay time, patient age, or stroke severity. I believe the literature is lacking a discussion about this potentially fatal outcome and more research should be done in this area.

Delays in Treatment

Zerna et al. (2018) identified that approximately 25% of all ischemic strokes are eligible for thrombolysis, however Rhew et al. (2017) states that fewer than 5% of patients who are eligible for acute treatment actually receive intravenous thrombolytic drugs. The literature presented an extensive list of reasons treatment may be delayed, and it can be broken down into three sub-categories.

Timing. The causes of Alteplase administration delay highlighted by these articles are factors that must be considered and planned for, but in most cases cannot be avoided. Rhew et al.

(2017) starts this discussion by stating that at least 50% of the United States population lives further than 60 minutes travel time from a primary stroke center which is further complicated by the finding of Speirs & Mitchell that "most time is lost in the prehospital setting primarily because patients delay seeking medical attention" (2015, p. 382). Two studies looked at patients who arrive on 'off-hours,' noted to be nights, weekends, and holidays, but had polar opposite results. Man et al. (2020) found that patients arriving with ischemic stroke during these off-hours did not experience longer DNT than patients arriving during weekday daylight hours as where Yang et al. (2014) acknowledged studies claiming this but found themselves that patients arriving during off-hours had longer DNT and were associated with poorer outcomes and mortality rates. Yang et al. did go on to hypothesize that these results may be reflective of common off-hour handicaps such as "discontinuity of care, inadequate staffing, reduced availability of interventions, and an overall reduction in supervision of patients" (2014, p. 887). Jaffe et al. (2020) looked at the impact of emergency department crowding on DNT and found that there were no significant delays associated with increased crowding. Jaffe further postulated that these findings may be due to increased resource availability during times of peak crowding, which were found to be from "Monday through Thursday the median ['severe crowding'] activation time of 1:35pm" (2020, p. 894).

Triage. The majority of identified delays in Alteplase administration throughout the literature were found within the triage process. Triage staff have been found to either misdiagnose a stroke, or miss a stroke altogether when patients presents with poor baseline function (Min-Yi et al., 2019), mild stroke with isolated symptoms or minor neurologic deficits (Yoo et al., 2018), or stroke mimics such as seizures, syncope, sepsis, conversion disorder, migraine, brain tumor, or hypoglycemia (Catangui, 2019). Yoo et al. (2018) goes on to discuss

how the initial non-diagnosis or misdiagnosis of stroke can delay all subsequent interventions, ultimately effecting DNT and outcomes.

One surprising finding was emergency department (ED) staff reliance on EMS personnel to identify strokes and give pre-notification prior to arrival creating a false sense of security. While the workflow improvement project focuses on patients arriving via personal vehicle, I feel it is necessary to recognize this bias as it creates unequal assessment performance based on the patient's mode of arrival. Tennyson et al. was that "stoke patients arriving via the 'front door' enjoyed more timely recognition and resource activation by ED staff than those arriving via the ambulance entrance if EMS had not already recognized the stroke symptoms in the field" (2019, p. 346) which was further corroborated by Speirs & Mitchell who cited "no pre-notification of the impending arrival of a stroke patient" (2015, p. 381) as an identified delay in treatment.

Hospital processes. The remainder of the identified delays in Alteplase administration involve the current procedures, implementations, or lack-there-of within the emergency department and included uncontrolled hypertension on arrival associated with a more than 30 minute delay to pharmacologically manage (Tran et al., 2019), location of the computed tomography (CT) scanner, lack of dedicated stroke team, lack of standardized stroke treatment protocols, inefficient patient flow, and the serial processing of multiple tasks (Speirs & Mitchell, 2015). One delay noted in both articles was the time taken for laboratory and imaging tests to result associated with a delay of up to 60 minutes (Speirs & Mitchell, 2015; Tran et al., 2019).

Proven Time Reduction Techniques

The summation of literature yielded a list of improvement opportunities which are directly transferrable to this specific workflow improvement project as well as to any emergency

department wishing to reduce their DNT. Operational interventions shown to be effective in reducing DNT and/or improving outcome include the implementation of a clinical pathway or systematic alert system (Yang et al., 2014), creating and training stroke teams, implementing preapproved standardized treatment protocols, postponing nonessential components of care until after completion of the CT scan, creation of a readily available 'stroke box' stocked with all necessary supplies for tPA administration (Speirs & Mitchell, 2015), utilizing a standard order set or written care protocols within an electronic medical record (EMR) (Elder et al., 2015), and providing educational programs for ED triage staff to ease early and accurate detection of stroke (Yoo et al., 2018). Speirs & Mitchell (2015) go on to discuss the importance of gaining administrative support with these implementations and the benefits of continually monitoring and evaluating performance of staff post-implementation.

The literature regarding the creation of a standard order set was of key importance, as this plans to be a primary element of my workflow improvement project. Elder et al. considers the importance of a standing order set as part of a multidisciplinary approach to stroke treatment when integrated within the EMR at primary stroke centers and cites that "a patient treated without the order set was 2.4 times more likely to receive care that was not in compliance with all mandatory standards" (2015, p. S8). This study further found that of the physicians who utilized the order set, 94% were neurologists, and that many of the physicians made modifications to the order set, thus defeating the purpose of standardization (Elder et al., 2015).

Chapter 3. PROJECT PLAN

Project Aim, Objectives, and Desired Outcomes

The overall aim of my capstone project is to decrease the time from door to Alteplase (tPA) administration in applicable patients arriving to the emergency department via personal vehicle in a community hospital. There are a number of contributing factors that can delay the administration of this potentially life-saving medication, and they are portrayed in the following fishbone diagram, Figure 1. Starting with the patient's themselves, the method of transportation to the hospital can remove precious time. Some patients exhibit denial that they are having a stroke and may try to ignore symptoms or self-medicate with over-the-counter medications for various symptoms. One would hope that a patient experiencing stroke symptoms would have a family member or loved one drive them to the hospital, or more preferably call EMS, but sometimes these extraneous bystanders can actually hinder care by trying to overstep medical professionals, interject into assessment questions, or giving incorrect details about the patient's last known well time (LKWT).

Once the patient reaches the hospital, they are seen by triage in the order of which they arrive, unless someone is obviously bleeding or in acute distress which is not always the case in stroke patients with minimal or early symptoms. Stemming from that same thought, the triage nurse is always prone to missing stroke symptoms since only a small portion of the patient's story is told and some patients have slight or atypical symptoms. The flawed process is where I aim to implement change in that the patient is typically put into a room where other menial tasks are completed, the physician is off seeing other patients and time is lost. Once the physician does see the patient a number of factors must still take place before the patient can receive their CT scan; an assessment must take place and stroke alert called, an order for the scan must be written, the patient must have an intravenous line, no contrast allergies, and good renal function, and the radiology department must be prepared to take the patient. Given this extensive list of factors, we

aim to improve the order of the process to help eliminate domino-effect delays in Alteplase administration.

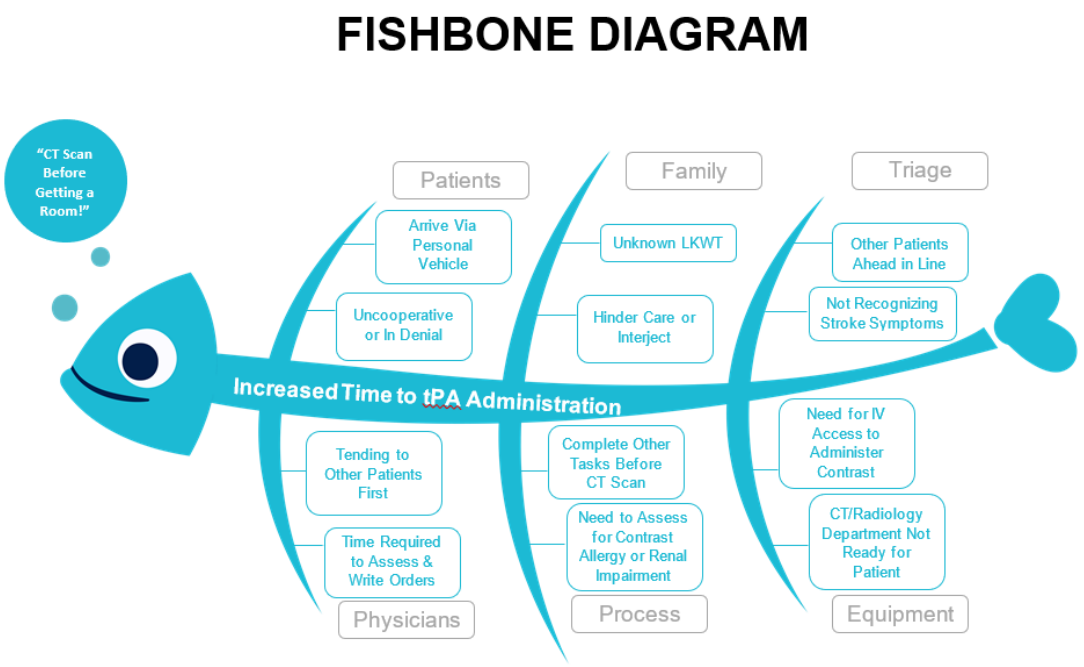

Figure 1. Fishbone Diagram

Plan, Do, Study, Act (PDSA Cycle)

As discussed in various pretenses, the less time that lapses from when the patient arrives to the time, they receive Alteplase has been directly linked with better overall outcomes and decreased long-term residual deficits. The national average as dictated by the American Heart Association is that the stroke patient receives Alteplase administration within 60 minutes of being through the emergency room door (American Heart Association, 2020). Unfortunately, less than 30 percent of patients nation-wide are treated with Alteplase within this window (American Heart Association). One study researched the correlation between door to Alteplase time and 1-year-all-cause mortality and readmission; this same study found that "every fifteen-

minute increase in door-to-needle time was associated with higher 1-year all-cause readmission and higher 1-year all-cause mortality" (Man et al., 2020, p. 2181). It is for this reason that we aim to re-design the current workflow of triaging stroke patients in the emergency department.

As shown in the plan, do, study, act cycle diagram, Figure 2, this begins with observing the current process and creating a new workflow for approval by the stroke committee and emergency department management. Once this is approved, education can be dispersed, and the implementation can be brought about. After a short period of implementation, the new workflow should be observed again and feedback from staff as well as metrics should be collected and assessed. Finally, utilizing this data and staff feedback, the workflow should be modified as needed, if applicable, and new education provided throughout.

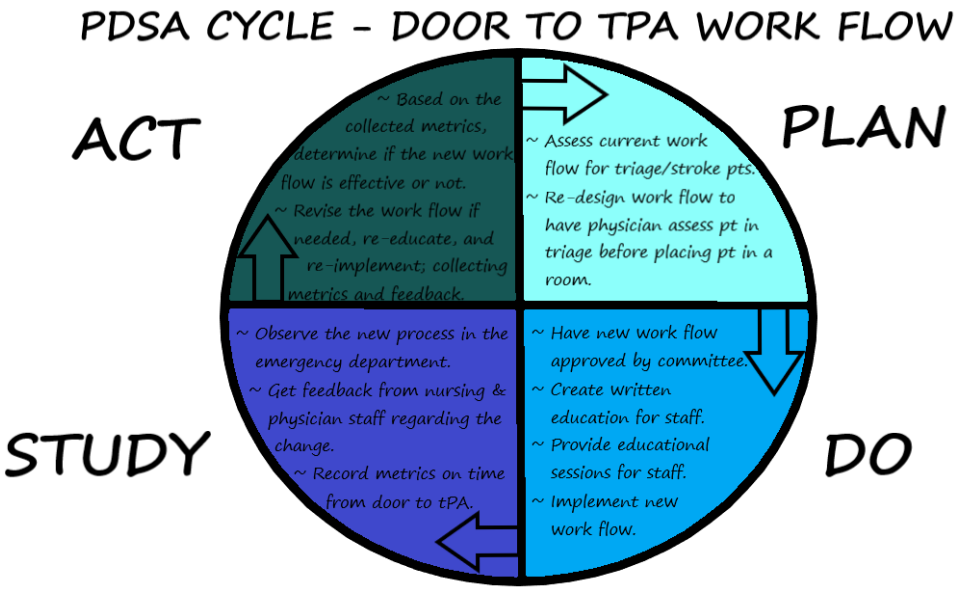

Figure 2. Project Planning Model Based on PDSA Cycle

Plan

The projection as shown in the run chart, Figure 3, is that the current door to Alteplase time frame, while currently acceptable, continues to trend shorter to ensure the best possible patient outcomes to a goal of 45 minutes or under by 2021. This will be achieved by taking the current stroke workflow and altering it so that the patient is taken directly from triage to the CT scanner before being placed in a room where other nonessential tasks may be completed and take up unnecessary time. A standard order set will be put in place to allow triage personnel to identify a stroke, activate the stroke alert, and get the patient to the CT scan all before the physician comes to assess the patient.

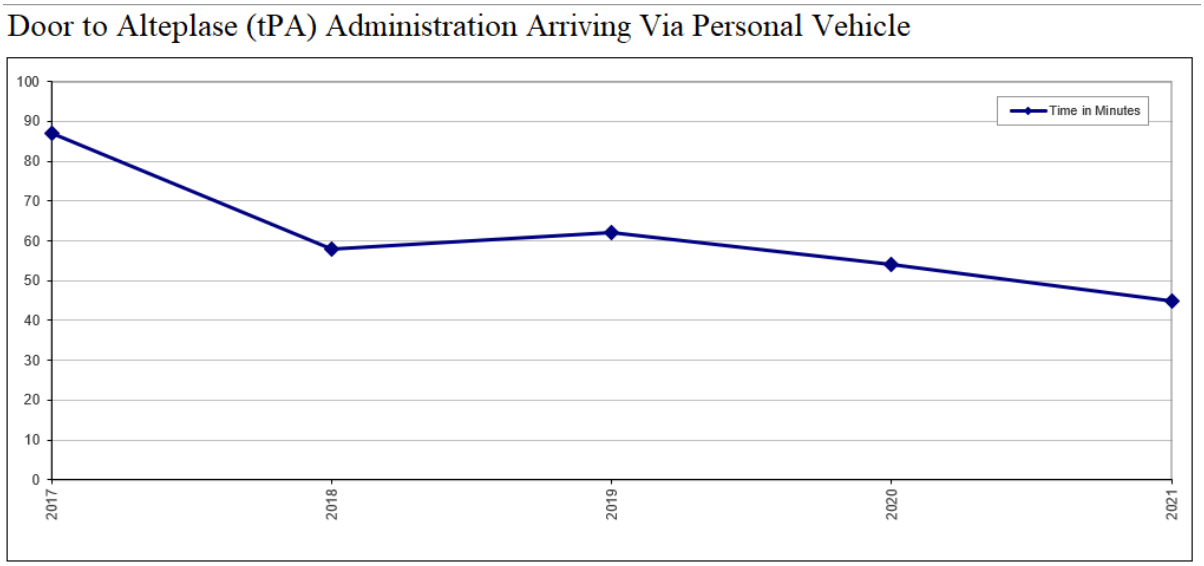

Figure 3. Run Chart

Do

The following action plan outlines the timeline for this project from development through completion.

1) Week of 6 September 2020: Observe current triage process for patients arriving via personal vehicle with stroke symptoms.

2) Week of 20 September 2020: Observe the current process for levels one, two, and three stroke alerts from door to Alteplase administration.

3) Week of 4 October 2020: Create new workflow and associated chart for staff to review.

4) Week of 18 October 2020: Present to emergency room staff, management, and educators for feedback and adjust as necessary.

5) Week of 1 November 2020: Once finalized, present to higher management, policy board, and physician staff for approval.

6) Week of 15 November 2020: Once approved create written and verbal education for staff and schedule sessions to provide training.

7) Week of 29 November 2020: Implement, re-educate where necessary and begin measuring outcomes.

In terms of additional resources required, the staff is already in place and this improvement project should not require any additional financial support. The hospital is staffed with a primary stroke coordinator who oversees all stroke alerts, and the ED staff responsible for carrying out this new workflow are the same employees currently practicing the old workflow. Education is the only additional resource required to implement this change in the ED.

Study

Measuring the outcomes of this implementation process will include a combination of personal observation, survey collection, chart audits, and metric data collection. Following the implementation, I will personally be walking around the ED making observations about how often the new workflow is being utilized, if there are any areas of this new workflow that are

impractical within the unit, and if there are any outward displays of frustration about the implementation from staff or patients. Once the implementation has been live for a short period of time, I will reach out to staff to fill out a survey regarding their satisfaction with the new workflow and allowing an area for them to anonymously make suggestions for areas of improvement within the new system. Once staff feedback have been collected, there will be a period of chart auditing by the primary stroke coordinator of patients with acute ischemic stroke who arrive via personal vehicle to ensure the standard order set has been not only utilized, but done so accurately and consistent across the documentation. These audit results will be reported back to myself by the primary stroke coordinator. Finally, the metric data of DNT will be collected from the patients who arrive to the ED during the implementation period and these numbers will hopefully trend down from where they previously were towards the goal of 43 minutes.

Act

The findings will be utilized to go back and refine the improved workflow, primarily based on the staff feedback on practicality and the final metrics of whether or not this implementation does reduce DNT within the ED. If staff identify an area of the new workflow that is not able to be carried out in the manner that it was intended, or if there are any areas that they feel are continually being missed or overlooked, that will be the focus of change on a revised model. I anticipate that at least one revision will need to be made between implementation and final project completion in order for staff to utilize it consistently and value its worth towards reducing DNT.

Chapter 4. FINDINGS AND OUTCOMES

Findings

The planning of this project was a lengthy process that involved collaboration with more groups and stakeholders than we initially projected. Developing a new workflow for patients arriving to the hospital via personal vehicle with an acute ischemic stroke was an improvement project that the primary stroke coordinator at the hospital had intended to complete for months prior to my arrival into the microsystem. This worked to our advantage because the idea had already been suggested to management within the emergency department (ED) and to the physicians working within this unit, so it was not a new proposal, however none of us could have accounted for the interjection of the Covid-19 pandemic which complicated our ability to gain approvals.

The initial step in the plan, do, study, act (PDSA) cycle was to assess the current workflow for not only stroke patients, but for the triage team in general, and design an improved workflow allowing the physician to assess stroke patients in the triage area to facilitate obtaining their CT scan prior to being placed in an ED room. The new workflow was developed, but in further discussion with the hospital stroke committee it was suggested that we look into a nurse driven approach which would allow the triage nurse to initiate the stroke alert process and take the patient to CT. Identifying exact roles for each team member involved proved to be a setback as the emergency department is an ever-changing environment in which staff availability and patient acuity can fluctuate from hour to hour. The main areas of contention were ultimately deciding which staff members would be in charge of: 1) notifying the physician of the incoming stroke patient, 2) contacting the Patronus Neurology to initiate a tele-consult, and 3) physically taking the patient from the triage area to the CT scanner. It was determined that flexibility will

be paramount in this workflow; staff knowing the steps of the new process in order will allow whichever staff is available to complete the next chain in the process.

Ideally, the triage nurse will identify the symptoms of a stroke, determine last known well time (LKWT), call a level 1 stroke alert via a Mobile Heartbeat telephone device which will send a broadcast to patient registration, radiology, the physicians, and the charge nurse identifying that a stroke alert has been called. This sets into motion the stroke alert process in which patient registration enters the patient into the electronic health system, radiology prepares a room to perform a head scan on the patient, the patient care technician contacts Patronus Neurology and obtains the mobile machine to place in the room, and the charge nurse aids in transporting the patient to radiology and then back to the pre-determined ED room. This workflow was compiled into a visual aide and presented to both the stroke committee and the ED physician's group at their respective meetings which leads us into the "do" portion of the PDSA cycle in which the new workflow is approved.

The new workflow for patients arriving to the ED via personal vehicle with stroke symptoms was approved by both groups, however at this point in the implementation process the Covid-19 pandemic had begun to consume the microsystem's resources. The influx of Covid-19 patients meant that there were less available beds for patients to be treated, less available staff to bring into the implementation process, and less accessibility for myself as a student to access the unit. Over the following weeks as cases continued to rise, the ED management enacted a change that all staff would be required to wear full personal protective equipment (PPE) garb to enter the unit and such precious resources were understandably not to be utilized by students. We began to develop a plan to implement the project from outside the unit and brainstormed ways to provide education without being physically in the department, however the hospital eventually

restricted students from practicing within the facility at all. Mental fatigue and staff burnout were also taken into consideration within this phase of the PDSA cycle, and with Covid-related policy changes occurring sometimes daily we ascertained that this was not the time to proceed with a major process change.

The implementation of this project, however, was not abandoned. Continuing on with the "do" phase of the PDSA cycle, we developed written and virtual education in the form of a pocket card for staff with the streamlined new workflow and a more in-depth power-point presentation explaining the reason for the change and the semantics of the workflow. This education and all steps from this point will be set aside and held for future implementation after the Covid-19 pandemic subsides.

A single walk-through of the new workflow was completed by the primary stroke coordinator with the unit educator on a patient who arrived via personal vehicle with stroke-like symptoms with LKWT less than 4.5 hours. This continues the PDSA cycle into the "study" phase in which the original plan was to observe the new process, gain feedback from unit staff regarding the change, and record metrics of various times from door to intervention. As shown below in Figure 4, this change in workflow was extremely successful in reducing times from patient arrival to stroke alert broadcast, patient arrival to obtaining a head CT scan, and patient arrival to Patronus Neurology tele-consult as compared to the average times measured from the 2020 fourth quarter utilizing the previous workflow.

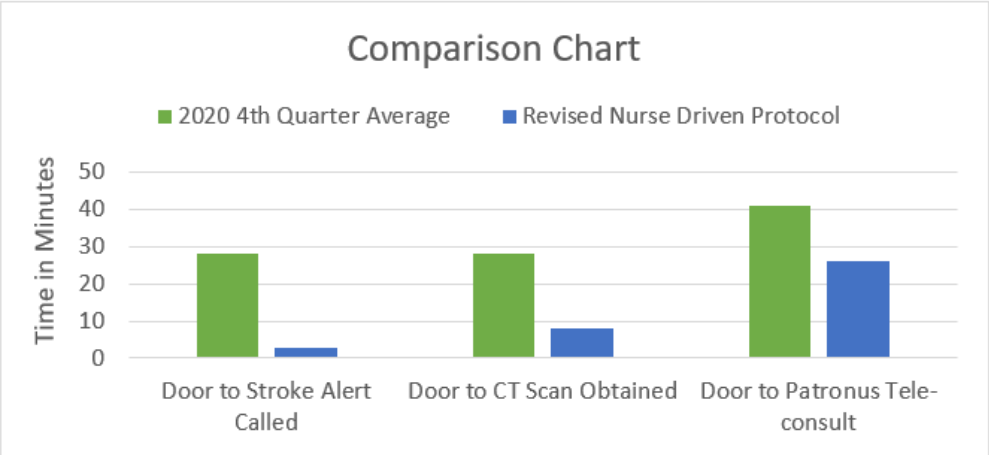

Figure 4. Comparison Chart

Finally, in the "act" phase of the PDSA cycle it was intended that based on the metrics and staff feedback collected, the workflow would again be revised as necessary with new education developed and a new implementation date determined. These steps of reviewing data collected, revising, re-educating, and re-implementing would continue on until the workflow was perfected to a point of proficiency where outcomes show marked improvement in time reduction and staff are confident in their ability to smoothly flow through the steps. Considering we were unable to complete this full cycle due to the Covid-19 pandemic, we would advise these to be the next steps in implementing this evidence-based practice project in the future.

Evaluation

The overall aim of this implementation project was to decrease the time from door to Alteplase (tPA) administration in applicable patients arriving to the ED via personal vehicle through the use of a revised workflow for staff from the one previously utilized. This overarching goal was to be met through the following objectives: 1) identify the areas of delay throughout the previous stroke process, 2) find solutions to overcome these delays to insert

logically into the workflow, 3) reorganize the workflow to prioritize obtaining the head CT before any other menial tasks, and 4) improve interdisciplinary communication throughout the department about stroke patient arrivals and treatment.

To meet the first and second objective collectively, a fishbone diagram was developed and delays in the stroke workflow were categorized into six groups: patients, family, triage, physicians, process, and equipment. Each of these hinderances were individually discussed and solutions to each were proposed and included in the revised workflow. This alone was suspected to be enough to reduce the door to needle time, however we wanted to lessen this time span as much as possible which drove us to the next objective.

Time management is a concept that nurses are taught early in school and work their whole career to master. In order to attain the most efficient use of their time, nurses often group tasks together such as performing a physical assessment while dressing the patient in a hospital gown or establishing an intravenous line while drawing blood work. The largest delay in treatment was found to be placing the patient in the ED room prior to obtaining the head CT scan, and this was confirmed throughout the PDSA cycle in observing nurses clustering their tasks as described above. Each small task that would seemingly only take a minute of the nurse's time began to add up to a significant delay in the time from which the patient was placed in the ED room to the time they were taken out of that room for their CT scan. Once this was identified, this objective was met through the use of a nurse-driven stroke alert protocol beginning in the triage department and ending in the ED room only after obtaining the head CT scan.

Finally, we noted that interdisciplinary communication was going to be a large obstacle while early in the planning phase. It appeared that blame was being passed around among the

different roles about who should be held accountable for each task in the previous workflow and this created animosity among the groups when these steps were being missed. Clear role determination was going to be a significant factor in achieving this objective, which as discussed above is difficult in a department with fluctuating staff availability and patient acuity. This objective was partially met as there are clear role definitions at every step except for one area. The exact staff member taking the patient from the triage desk to the CT scanner depends heavily on availability of the charge nurse, crowding in the ED on the triage nurse, and staffing ratios of patient care technicians. The workflow was developed to allow any of these three personnel to complete this task with the understanding that it needs to be communicated to the rest of the team. The use of the Mobile Heartbeat telephone device has played a useful role in achieving this objective as well because it allows the triage nurse to easily broadcast the stroke alert to all necessary team members from the touch of a button.

Chapter 5. IMPLICATIONS AND CONCLUSION

Project Impact on Quality Care and Cost

While the primary stroke coordinator is a certified clinical nurse leader (CNL) and operates in many ways as such, this health system does not staff a CNL as a stand-alone role and therefore it seemed foreign to some within the microsystem. One of the primary functions of the clinical nurse leader is to utilize leadership skills and lateral integration to collaborate with the members of a microsystem to promote evidence-based practice changes to improve patient safety and outcomes. This project captured all aspects of this definition as we identified where there was a need for improvement, collaborated with interdisciplinary team members, and reviewed pertinent literature to reach a tangible workflow to implement to reduce door to needle time in ischemic stroke patients arriving via personal vehicle. Through this project we were able to

improve the staff's daily workflow while concurrently introducing the CNL role to members of this microsystem.

This improvement project had been a discussion long before I stepped foot in the hospital as something that needed to be done do not only improve patient outcomes through a reduced door to needle time, but also to help cut hospital costs as a secondary objective. When patients come to the hospital with a medical emergency, they anticipate to receive the highest quality of care regardless of extenuating circumstances. Developing a new workflow for stroke patients arriving via personal vehicle has helped the ED staff deliver on this promise by streamlining the necessary tasks in an order that allows for the least interruptions and by eliminating areas of common time delay. Through patients receiving Alteplase in a timelier manner, they will appreciate a lower mortality rate and a lower incidence of lasting deficits, thus reducing their healthcare expenses and improving their all-around quality of life. By receiving this higher quality of care, patients are more likely to return to this facility for their future medical needs, thus retaining the hospital's overall fiscal stability.

Significance

The significance of this revised stroke workflow on nursing is that it will allow the ED nurses the best opportunities for successful Alteplase administration within the 4.5-hour window and within the national average of 60 minutes door to needle time. Medical professionals within the ED collectively want to treat each patient with the highest quality care to promote the best outcomes, but sometimes this is not feasible given staffing or policy constraints. By eliminating interruptions and delays throughout the stroke alert process, nurses will be more confident in their ability to have stroke patients assessed and treated in a timely fashion. This project has also empowered triage nurses to identify and call a stroke alert independently without relying on a

physician to confirm their suspicions or write orders in the electronic medical record. This level of autonomy brings about a more open communication and a higher level of trust among a previously discorded relationship between physicians and nurses.

Conclusion

In conclusion, through the use of a revised workflow for patients arriving via personal vehicle with an ischemic stroke we were able to reduce the time from door to stroke alert called, CT scan obtained, and Patronus Neurology tele-consult placed on one patient. Areas of time delay were identified and remedied and a revised workflow was created and approved for use once the pandemic lessens. An extensive literature review was performed to identify best practice interventions, and these were utilized to develop the revised workflow to improve patient outcomes. A nurse-driven protocol was initiated which empowers the triage nurse to identify a stroke, broadcast a level one stroke alert to necessary team members, and facilitate transport of the patient to the CT scanner all independent of physician guidance. Areas of breakdown in team communication were identified and resolved as well throughout this process. Due to the Covid-19 pandemic we were unable to fully implement the project at this time, however education and an implementation plan has been developed for future use.

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Appendix A.

Evidence Appraisal Matrix

#	APA Source	Type of Study design/ Purpose	Level of Evidence	Sample, Setting, Inclusion/ Exclusion Criteria	Methods, Instruments, Data Analysis	Findings/Implications
1	Rhew, D. C., Owens, S. H., Buckner, J. B., & Kueider, S. S. (2017). A Rural Hospital's Journey to Becoming a Certified Acute Stroke-Ready Hospital: JEN. *Journal of Emergency Nursing, 43*(1), 33-39.	Qualitative Descriptive Study Purpose: "To share our journey as we became the first rural hospital in North Carolina to be awarded the Joint Commission Acute Stroke Ready Hospital (ASRH) certification" (Rhew et al., 2017, p. 33).	VI	Sample: N/A Setting: 113-bed rural hospital in Rockingham County, NC over the span of 10 months Inclusion & Exclusion Criteria: N/A	Methods: Formed an Interdisciplinary Continuous Process Improvement (CPI) team. Conducted a gap analysis to examine current stroke care processes and to identify areas that needed to be improved. Performed chart audits to ensure compliance with implemented changes. Instruments: Requirements for recognition as an Acute Stroke Ready Hospital (ASRH) were reviewed and consulted throughout Data Analysis: Measured 4 outcomes: (1) door-to-needle time, (2) door-to-CT scan results, (3) door-to-INR results, and (4) teleneurology consultation time	"Stroke is a national health problem, affecting 7 million people in the United States and leading to 795,000 hospitalizations" (Rhew et al., 2017, p. 33) "Stroke is the leading cause of disability in the U.S." (Rhew et al., 2017, p. 33) "Estimates indicate that every 40 seconds someone sustains a stroke and every 4 minutes someone dies from a stroke" (Rhew et al., 2017, p. 33) "Stroke is the third leading cause of death with an estimated 750,000 Americans experiencing a new or recurrent stroke event every year, contributing to 160,000 deaths annually" (Rhew et al., 2017, p. 33) "At least 50% of the population in the U.S. does not live within 60 minutes travel time of a primary stroke center." (Rhew et al., 2017, p. 33) "Fewer than 5% of patients with an acute ischemic stroke who are eligible for acute treatment receive intravenous thrombolytic drugs" (Rhew et al., 2017, p. 33) "During tPA administration, vital signs and neurologic checks should be completed and documented every 15 minutes for 2 hours, then every 30 minutes for 6 hours, then every hour until 24 hours after the tPA bolus is administered" (Rhew et al., 2017, p. 37) This hospital reduced: (1) Door-to-needle times from 111min to 76min, (2) door-to-CT results from 38min to 32.14min, (3) door-to-INR results from 51min to 46.6min, and (4) teleneurology request to video call from 15min to 13min (Rhew et al., 2017, p. 39).
2	Min-Yi, L., Chen, C., Shin-Joe Yeh,	Cohort Study	IV	Sample: From a single-center registry of 2813	Methods: Compared the outcomes including successful	"Endovascular thrombectomy (EVT) is the standard acute

	Li-Kai, T., Chung-Wei, L., Sung-Chun, T., & Jeng, J. (2019). Comparison between in-hospital stroke and community-onset stroke treated with endovascular thrombectomy. *PLoS One*, *14*(4), 1-12.	Purpose: "The objective of the study was to compare the functional outcome, reperfusion efficacy, and safety between patients in the IHS and COS groups" (Min-Yi et al., 2019, p. 3).		patients with ischemic stroke, those who had received EVT for acute ischemic stroke were included and classified into two groups. 24 patients with in-hospital stroke (IHS) and 105 patients with community-onset stroke (COS). Included all consecutive acute ischemic stroke cases between January 2015 and December 2017. Setting: University affiliated medical center with more than 2000 beds. Inclusion & Exclusion Criteria: Included (1) groin puncture could be initiated within 6 h for anterior circulation stroke and within 24 h for posterior circulation stroke; (2) evidence of occlusion of the intracranial large artery, and (3) the existence of large ischemic mismatch/penumbra based on CT perfusion scan for anterior circulation stroke. Excluded intracranial hemorrhage on noncontrast brain computed tomography scan.	recanalization, symptomatic intracranial hemorrhage, functional independence utilizing the modified Rankin Scale score at 90 days, and mortality between the two groups. Instruments: Modified Rankin Scale Tool Stroke severity was evaluated using National Institutes of Health Stroke Scale (NIHSS) scores A score of 2b or 3 in the modified Thrombolysis in Cerebral Infarction (mTICI) scoring system was defined as successful recanalization. Data Analysis: Stroke registry at the National Taiwan University Hospital (NTUH) was used to study the etiologic factors, clinical courses, prognoses, and complications of stroke. Continuous variables were compared between the IHS and COS groups by using the Student's *t* test or Mann-Whitney U test and categorical variables were compared using Chi-square or Fisher exact test.	treatment for large vessel occlusion strokes" (Min-Yi et al., 2019, p. 2). "Because some patients with IHS may be ineligible for treatment with intravenous recombinant tissue plasminogen activator (rt-PA) due to comorbidities or contraindications, early recanalization through EVT becomes a vital therapeutic choice" (Min-Yi et al., 2019, p. 2). "The proportion of patients who received intravenous thrombolysis were significantly lower in the IHS group than in the COS group (3.6% vs 7.3%)" (Min-Yi et al., 2019, p. 4). "Previous studies have suggested that patients with IHS had worse functional dependence, which was usually attributed to poor baseline function and delay in diagnosis and timely intervention" (Min-Yi et al., 2019, p. 7). "A faster reperfusion time is usually associated with more favorable outcomes in acute ischemic stroke" (Min-Yi et al., 2019, p. 9). "Patients with IHS generally experience a substantial delay in stroke symptom recognition, neurological evaluation, and appropriate intervention" (Min-Yi et al., 2019, p. 9).
3	Zerna, C., Thomalla, G., Campbell, B. C. V., Joung-Ho Rha, & Hill, M. D. (2018). Current practice and	Expert Opinion and Consensus Purpose: "Ischemic stroke is immediately treatable with reperfusion therapy and this	VII	Sample: N/A Setting: N/A Inclusion & Exclusion Criteria: N/A	Methods: Many previous studies are referenced and cited, but there is no formal comparison or systematic review of the literature. Instruments: N/A	"Neuroimaging is the most important biomarker to help differentiate between stroke subtypes and assess treatment eligibility" (Zerna et al., 2018, p. 1247). "Therapeutic advances have led to intravenous thrombolysis with

	future directions in the diagnosis and acute treatment of ischemic stroke. *The Lancet, 392*(10154), 1247-1256.	Series paper will focus on the management of acute ischemic stroke syndromes" (Zerna at al., 2018, p. 1247).			Data Analysis: N/A	tissue-type plasminogen activator and endovascular treatment for proximal vessel occlusion in the anterior cerebral circulation being standard care for acute ischemic stroke" (Zerna et al., 2018, p. 1247). "Ischemic stroke is caused by a focal occlusion or stenosis of an artery or multiple arteries in the brain or leading to the brain" (Zerna et al., 2018, p. 1247). "It [NIHSS score] is a guide that does not weight deficits or disability equally and is therefore a tool to aid, but not a substitute for, the clinical judgement of stroke severity" (Zerna et al., 2018, p. 1247). "Approximately 25% of all ischemic stroke is eligible for medical thrombolysis and 10-12% eligible for endovascular treatment" (Zerna et al., 2018, p. 1248). "Non-contrast CT allows differentiation between ischemic stroke and intracerebral hemorrhage and, in the case of an ischemic stroke, allows quantification of the extent of early ischemic changes by applying the Alberta Stroke Program Early CT Score (ASPECTS)" (Zerna et al., 2018, p. 1248). "A normal non-contrast CT does not rule out an acute ischemic stroke" (Zerna et al., 2018, p. 1248). "Imaging is the most important biomarker in acute ischemic stroke; it can define the cause, show the extent of potentially salvageable brain tissue, and aid the selection of acute therapies" (Zerna et al., 2018, p. 1250). "Alteplase - a single chain recombinant tissue plasminogen activator (tPA) - has been successfully shown to be an efficacious treatment for stroke and subsequently marketed worldwide for acute ischemic stroke treatment" (Zerna et al., 2018, p. 1250). "[...] licensing of alteplase in a 3-hour time window from stroke symptom onset" (Zerna et al., 2018, p. 1250). "There is a distinct benefit of alteplase that was greater the earlier

						it was given, approaching a neutral effect at 270 min from symptom onset" (Zerna et al., 2018, p. 1250). "There is no average benefit of alteplase administration after 270 min from stroke symptom onset" (Zerna et al., 2018, p. 1250). "The framework for acute ischemic stroke therapeutics is fast treatment with a door-to-needle time target of 30 min or less and rapid escalation to endovascular treatment for patients with large vessel occlusion" (Zerna et al., 2018, p. 1254).
4	Tennyson, J. C., Michael, S. S., Youngren, M., & Reznek, M. (2019). Delayed Recognition of Acute Stroke by Emergency Department Staff Following Failure to Activate Stroke by Emergency Medical Services. *The Western Journal of Emergency Medicine*, *20*(2), 342-349.	Retrospective Cohort Study Purpose: "We sought to determine if potential stroke patients transported by EMS, but for whom EMS did not provide pre-notification, suffer delays in ED door-to-stroke-team activation (DTA) as compared to the other available cohort of patients for whom the ED is not pre-notified – those arriving by private vehicle" (Tennyson et al., 2019, p. 342).	IV	Sample: 200 patients were included Setting: Urban, regional referral stroke center hospital with tertiary care status. Inclusion & Exclusion Criteria: Identified all consecutive patients who presented to the adult ED and met criteria for stroke team activation between June 15, 2014 and June 15, 2015. Exclusion criteria included delays in stroke care due to a more emergent management consideration such as airway management or blood pressure control.	Methods: Queried the prospective stroke registry to identify consecutive stroke team activation patients over 12 months and retrospectively reviewed the electronic health record for each patient. Compared patients arriving by private vehicle to those arriving by EMS without pre-notification, and employed a multivariable, penalized regression model to assess the probability of meeting the national DTA goal of < or = 15 minutes. Instruments: Massachusetts STroke Scale (MASS) Cincinnati Prehospital Stroke Scale Data Analysis: Based on the electronic timestamps for ED arrival and stroke team activation, door-to-activation (DTA) time for each patient in the stroke registry was calculated.	"Intervention for stroke patients is time sensitive, with guidelines recommending administration of intravenous (IV) recombinant tissue plasminogen activator (rt-PA) within 4.5 hours of symptom onset" (Tennyson et al., 2019, p. 342). Of the 200 patients included, 83 (41.5%) achieved DTA less than or equal to 15 minutes. DTA time ranged from less than 1 minute to 3hr 37min. "Among patients who arrived via EMS without prehospital activation, 32.1% achieved DTA less than or equal to 15min, compared to 52.1% among patients who did not arrive via EMS" (Tennyson et al., 2019, p. 345). "Potential stroke patients arriving without EMS pre-notification were only 55% as likely to meet the national 15-minute goal for DTA time as those arriving via means other than EMS" (Tennyson et al., 2019, p. 345). "Stroke patient's arriving via the 'front door' enjoyed more timely recognition and resource activation by ED staff than those arriving via the ambulance entrance if EMS had not already recognized the stroke symptoms in the field" (Tennyson et al., 2019, p. 346). "Observed results also may have been due to the success of EMS early identification and pre-notification efforts [...] potentially creating a false sense of security and causing ED staff to become over-reliant on EMS decision making" (Tennyson et al., 2019, p. 346).

5	Emberson, J., Lees, K. R., Lyden, P., Blackwell, L., Albers, G., Bluhmki, E., Brott, T., Cohen, G., Davis, S., Donnan, G., Grotta, J., Howard, G., Kaste, M., Koga, M., von Kummer, R., Lansberg, M., Lindley, R. I., Murray, G., Olivot, J. M., . . . Hacke, W. (2014). Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. *The Lancet*, *384*(9958), 1929-1935.	Meta-analysis Purpose: To assess the role or relationship among treatment delay, age, and stroke severity with good stroke outcomes at 3-6 months as measured by a modified Rankin score (mRS). Secondary outcomes measured included fatal intracranial hemorrhage within 7 days, any symptomatic intracranial hemorrhage, and 90-day mortality.	I	Sample: 6756 patients in nine randomized trials. Of these, in their respective studies 3391 patients received alteplase and 3365 were given either placebo or control. Setting: N/A - Multiple settings from each individual trial included. Inclusion & Exclusion Criteria: Included all completed randomized phase 3 trials of intravenous alteplase for treatment of actue ischemic stroke for which data were available.	Methods: Meta-analysis was completed on individual patient data from 9 randomized trials. Retrospective checks confirmed that no eligible trials had been omitted. Instruments: Modified Rankin score SITS-MOST assessment tool for parenchymal type 2 hemorrhage Oxford Handicap Scale assessment tool National Institutes of Health Stroke Scale (NIHSS) Data Analysis: "Logistic regression was used, stratified by trial, to model the common linear dependence of the log odds of a particular outcome on allocation to alteplase, treatment delay, age, baseline stroke severity, and interactions between allocation to alteplase and each of these other baseline covariates" (Emberson et al., 2014, p. 1931). Further analysis was completed with SAS version 9.3 and R-version 2.11.1.	"In the USA, the Food and Drug Administration has approved the use of alteplase only within 3h of stroke onset" (Emberson et al., 2014, p. 1930). "Strong relationships existed between patient age, treatment delay, and stroke severity in all trials" (Emberson et al., 2014, p. 1932). "Alteplase significantly increased the odds of a good outcome, with earlier treatment resulting in significantly greater proportional benefit" (Emberson et al., 2014, pp. 1932-3). "We estimated the time at which alteplase has no effect to be 6.3h" (Emberson et al., 2014, p. 1933). "Age did not change the effect of alteplase on odds of a good outcome [...] nor did we find clear evidence that stroke severity modified the effect of alteplase." (Emberson et al., 2014, p. 1933). "The proportional increase in risk of fatal intracranial hemorrhage was much the same, irrespective of treatment delay, age, or stroke severity" (Emberson et al., 2014, p. 1933). "We provide clear evidence for improved odds of a good stroke outcome when treatment is started within 4.5h of ischemic stroke, with earlier treatment resulting in bigger proportional and absolute benefits" (Emberson et al., 2014, p. 1933).
6	Catangui, E. J. (2019). Identifying and differentiating stroke and stroke mimics. *Nursing Standard*, *34*(4), 76-82.	Case Series Study Purpose: "The aim of this article is to describe stroke mimics and their presentations, to differentiate stroke mimics from a stroke and to provide nurses with practical	IV	Sample: N/A Setting: N/A Inclusion & Exclusion Criteria: N/A	Methods: Case study approach to improve nurses' understanding of some of the clinical presentations of stroke mimics. Previous studies were referenced and cited, but there was no formal literature review.	"A stroke mimic is defined as a non-vascular disease that presents with stroke-like symptoms, often indistinguishable from an actual stroke" (Catangui, 2019, p. 76). "The most common types of stroke mimic are seizures, syncope, sepsis, functional disorders such as conversion disorder, primary headache disorders such as migraine, brain tumor and metabolic

		information on triaging and identifying stroke and stroke mimics in the clinical setting" (Catangui, 2019, p. 76).			Instruments: The Recognition of Stroke in the Emergency Room (ROSIER) scale The National Institutes of Health Stroke Scale (NIHSS) Data Analysis: Case study review and discussion	disorders such as hypoglycemia" (Catangui, 2019, p. 76). "A patient experiencing a stroke mimic may present with symptoms that are similar to those of stroke, such as facial weakness, unilateral limb weakness, and visual and speech disturbances" (Catangui, 2019, p. 77). "The onset of symptoms of stroke mimics usually occur progressively, whereas the onset of a stroke is usually acute" (Catangui, 2019, p. 80).
7	Campbell, B. C. V., Ma, H., Ringleb, P. A., Parsons, M. W., Churilov, L., Bendszus, M., Levi, C. R., Hsu, C., Kleinig, T. J., Fatar, M., Leys, D., Molina, C., Wijeratne, T., Curtze, S., Dewey, H. M., Barber, P. A., Butcher, K. S., De Silva, D.,A., Bladin, C. F., . . . Williams, M. (2019). Extending thrombolysis to 4·5–9 h and wake-up stroke using perfusion imaging: a systematic review and meta-analysis of individual patient data. *The Lancet, 394*(10193), 139-147.	Systematic Review & Meta-analysis Purpose: "We did a meta-analysis of individual patient data to test the hypothesis that intravenous alteplase improves functional outcomes compared with placebo in patients with ischemic stroke 4.5-9h after onset or wake-up stroke who were imaged with CT perfusion or perfusion-diffusion MRI" (Campbell et al., 2019, p. 140).	I	Sample: 414 patients were included from 3 trials. 213 patients were assigned to receive alteplase and 201 patients received placebo. Setting: N/A - Multiple settings from each individual trial included. Inclusion & Exclusion Criteria: Randomized controlled trials published in English between January 1, 2006 and March 1, 2019 of the correct subject matter were included. Trials of intravenous alteplase versus placebo in adults with hemispheric ischemic stroke more than 4.5h after stroke onset or wake-up stroke who had pretreatment imaging with CT perfusion or perfusion-diffusion MRI were eligible for inclusion.	Methods: Completed a systematic search of PubMed for trials meeting inclusion criteria with keywords 'stroke,' 'randomized,' 'thrombolysis,' 'alteplase,' or 'tPA.' The reference list of a previous systematic review of thrombolysis was reviewed for additional trials that met inclusion criteria. ClinicalTrials.gov was searched for international studies of ischemic stroke using the keywords 'thrombolysis' and 'alteplase.' Primary outcome measured was the proportion of patients with excellent function outcome at 3 months. Secondary outcomes were function improvement at 3 months, functional independence at 3 months, and early neurological improvement. Safety outcomes measured were symptomatic intracerebral hemorrhage within	"Patients with ischemic stroke 4.5-9h from stroke onset or wake-up stroke with salvageable brain tissue who were treated with alteplase achieved better functional outcomes than did patients given placebo" (Campbell et al., 2019, p. 139). "76 (36%) of 211 patients in the alteplase group achieved the primary outcome of excellent functional outcome at 3 months compared with 58 (29%) of 199 patients in the placebo group" (Campbell et al., 2019, p. 143). "The number of patients with symptomatic intracerebral hemorrhage was significantly higher in the alteplase group than the placebo group [...] however, no significant differences were identified in mortality between the alteplase and placebo groups." (Campbell et al., 2019, p. 143). "[there is] strong evidence in support of thrombolysis for patients with favorable perfusion imaging 4.5-9h after stroke, including patients with wake-up stroke" (Campbell et al., 2019, p. 146).

					36h of treatment, neurological deterioration of 4 or more NIHSS points, or death. Instruments: National Institutes of Health Stroke Scale (NIHSS) modified Rankin Scale (mRS) Data Analysis: Mixed-effects ordinal logistic regression models were used and analyzed. Imaging data for individual patients were reprocessed using RAPID version 4.6.	
8	Man, Shumei,M.D., PhD., Xian, Ying,M.D., PhD., Holmes, D. N., M.S., Matsouaka, R. A., PhD., Saver, J. L., M.D., Smith, Eric E,M.D., M.P.H., Bhatt, Deepak L,M.D., M.P.H., Schwamm, L. H., M.D., & Fonarow, G. C., M.D. (2020). Association Between Thrombolytic Door-to-Needle Time and 1-Year Mortality and Readmission in Patients With Acute Ischemic Stroke: The Journal of the American Medical Association. *Jama,*	Retrospective Cohort Study Purpose: "This study aimed to test the hypothesis that shorter door-to-needle times for tPA are associated with lower 1-year all-cause mortality, all-cause readmission, and the composite of all-cause mortality or readmission among patients hospitalized with acute ischemic stroke" (Man et al., 2020, p. 2171).	IV	Sample: 61,426 Medicare beneficiary patients aged 65yr or older who were treated for acute ischemic stroke with IV-tPA within 4.5hr from the time of last known well. Setting: Get With the Guidelines – Stroke participating hospitals between January 1, 2006 and December 31, 2016. Most patients were treated at teaching hospitals (77.7%) and primary stroke centers (73.2%); 3% were treated at rural hospitals. Inclusion & Exclusion Criteria: Patients are required to (1) be 65yrs or older, (2) have a discharge diagnosis of acute ischemic stroke, (3) have been treated with IV-tPA within 4.5hr of the LKWT, (4) have a documented door-	Methods: Trained hospital personnel were instructed to collect the data from the Get With The Guidelines – Stroke database. To obtain longitudinal outcomes, the GWTG-Stroke records were linked to Medicare claims files by matching identifiers. Primary outcomes included 1-year all-cause mortality, 1-year all-cause readmission, and the composite of all-cause mortality or readmission at 1 year. A secondar outcome was 1-year cardiovascular readmission. A post hoc secondary outcome was recurrent stroke readmission. Instruments: None discussed.	"Shorter door-to-needle times were associated with lower all-cause mortality and lower all-cause readmission at 1 year" (Man et al., 2020, p. 2170). "Intravenous tissue plasminogen activator (tPA) has been demonstrated in randomized trials to improve 3-month functional outcomes after acute ischemic stroke, and 1-year to 1.5-year functional outcomes" (Man et al., 2020, p. 2171). "A series of key best practice strategies were disseminated to hospitals with the goal to achieve door-to-needle times within 60 minutes for at least 50% of patients treated with tPA" (Man et al., 2020, p. 2171). "More patients that arrived during off hours were treated within longer door-to-needle times" (Man et al., 2020, p. 2173). "Patients who received tPA after 45 minutes of hospital arrival had worse long-term outcomes than those treated within 45 minutes of hospital arrival, including significantly higher all-cause mortality" (Man et al., 2020, p. 2173). "Patients who received tPA after 60 minutes of hospital arrival vs within

	323(21), 2170-2184.			to-needle time, (5) not have been treated with a concomitant therapy, (6) have had the admission be the first for stroke during the study period, and (7) not have been transferred to another hospital or leave AMA. 41,195 patients were excluded because they could not be matched to Medicare claims file data.	Data Analysis: Person x2 test was used for categorical variables and the Wilcoxon rank-sum test for continuous variables. Standardized differences were used for comparisons between 2 groups. Cox proportional hazards models were used to examine associations timeliness. The proportional hazards assumption was assessed using the Schoenfeld residual test. Cumulative incidence curves were generated to estimate the incidence of each outcome of interest. All statistical analyses were performed using SAS version 9.4.	60 minutes of hospital arrival had significantly higher adjusted all-cause mortality, higher all-cause readmission, higher all-cause mortality or readmission, and higher cardiovascular readmission" (Man et al., 2020, p. 2179). "Every 15-minute increase in door-to-needle times was significantly associated with higher all-cause mortality, [...] higher all-cause readmission, and higher all-cause mortality or readmission "Man et al., 2020, p. 2179). "Every 15-minute increase in door-to-needle time up to 90 minutes was significantly associated with worse 1-year outcomes" (Man et al., 2020, p. 2179). "A door-to-needle time within 30 minutes was not associated with even better outcomes [than within 45 minutes]" (Man et al., 2020, p. 2182).
9	Jaffe, T. A., Goldstein, J. N., Yun, B. J., Etherton, M., Leslie-Mazwi, T., Schwamm, L. H., & Zachrison, K. S. (2020). Impact of Emergency Department Crowding on Delays in Acute Stroke Care. *The Western Journal of Emergency Medicine, 21*(4), 892-899.	Retrospective Cohort Study of Prospectively Collected Data Purpose: "We aimed to determine the relationship between emergency department (ED) crowding and the delivery of timely emergency stroke care" (Jaffe et al., 2020, p. 892). Outcomes of interest were door-to-imaging time (DIT), door-to-needle time (DTN), and door-to-groin puncture time (DTP)	IV	Sample: 1379 patients with ischemic stroke presented during the study period of July 2016 – August 2018. Of the 1379 total sample patients, 495 patients were potentially eligible for intervention and after exclusion criteria a remaining 298 patients were included. Setting: High-volume, urban, academic emergency department Inclusion & Exclusion Criteria: Included all patients over 18yrs of age	Methods: Prospectively collected data from the Get with the Guidelines Stroke Registry. Utilized capacity logs to determine the degree of ED crowding at the time of patients' presentation and classified them as ordinal variables. Regression models were used to examine the relationship between the crowding level and outcome metrics. Instruments: National Institutes of Health Stroke Scale (NIHSS)	"We found no significant delays in stroke care delivery associated with increased ED crowding" (Jaffe et al., 2020, p. 892). "National guidelines recommend administration of alteplase within 60 minutes of patient presentation" (Jaffe et al., 2020, p. 892). Previous studies have reported that "increased crowding was associated with poorer performance on door-to-imaging times (DIT)" (Jaffe et al., 2020, p. 893). "Increased crowding activations occurred Monday-Thursday, with the median time of activation 1:35pm" (Jaffe et al., 2020, p. 894). "Median DIT among this cohort was 26 minutes and did not significantly differ by ED capacity constraints at time of presentation" (Jaffe et al., 2020, p. 895).

				with a final diagnosis of ischemic stroke. Door-to-imaging analysis excluded all transferred patients to eliminate anyone who may have had previous imaging done. Door-to-needle analysis included all patients arriving within 4.5hr of last known well time (LKWT) and treated with Alteplase. Door-to-puncture analysis included all patients arriving within 8hr of LKWT with NIHSS > or = 6 who received endovascular therapy.	Data Analysis: t-tests, chi-square, and Wilcoxon rank-sum tests as appropriate for bivariate comparisons. Concluded analyses using the Stata 14.2 program.	"Among the 82 alteplase-treated patients in our sample, median DTN was 43 minutes and did not significantly vary by ED capacity status at time of presentation" (Jaffe et al., 2020, p. 895). "Among the 52 patients who received endovascular therapy, median DTP was 68.5 minutes and did not vary by ED capacity status at time of presentation" (Jaffe et al., 2020, p. 895). "One potential explanation for our findings could be that times of peak crowding occurred concurrently with times of increased resource availability" (Jaffe et al., 2020, p. 897).
10	Yang, J. M., Park, Y. S., Chung, S. P., Chung, H. S., Lee, H. S., You, J. S., Lee, S. H., & Park, I. (2014). Implementation of a clinical pathway based on a computerized physician order entry system for ischemic stroke attenuates off-hour and weekend effects in the ED. *The American Journal of Emergency Medicine, 32*(8), 884-889.	Nonrandomized Controlled Trial with Retrospective Analysis Purpose: "The purpose of this study was to investigate whether an organized clinical pathway (CP) for ischemic stroke can effectively reduce differences in the time interval from ED arrival to evaluation and treatment, regardless of the time from arrival in the ED, by eliminating off-hour and weekend effects in ischemic stroke" (Yang et al., 2014, p. 885).	III	Sample: 649 consecutive patients were admitted to the ED and met inclusion during the study period of September 1, 2010 through September 30, 2012. Setting: Tertiary academic hospital with an annual ED census of 65,000 patients. Inclusion & Exclusion Criteria: The study included all patients within the study period with ischemic stroke or transient ischemic attack who presented to the ED within 12 hours of onset of symptoms. Patients were excluded from the study if a hemorrhagic stroke or brain tumor was revealed by noncontrast CT or if another medical	Methods: The Brain Salvage through Emergency Stroke Therapy (BEST) program, which is based on the computerized physician order entry (CPOE) system was utilized which, when activated, includes the entering of predetermined standing order sets and provides specific protocols and guidelines for care. Patients were classified into one of four groups based on their time of arrival in the ED. and the BEST program and thus CPOE were activated by the medical personnel in triage when a patient arrived meeting criteria. Clinical outcomes were categorized	"Admission on weekends and off-hours has been associated with poor outcomes and mortality from acute stroke" (Yang et al., 2014, p. 884). "No time intervals differed significantly among the 4 patient groups who received intravenous administration of tissue plasminogen activator (IV-tPA)" (Yang et al., 2014, p. 884). "Use of IV-tPA was not affected by arrival in the ED on off-days or weekends" (Yang et al., 2014, p. 884). "Intra-arterial thrombolysis or intravenous administration of tissue plasminogen activator (IV-tPA) can improve clinical outcomes for many patients with ischemic stroke if conducted rapidly after the onset of acute stroke" (Yang et al., 2014, p. 884). Previous studies suggested that "admission on the weekend or during off-hours has also been associated with poor outcomes and mortality from acute stroke" (Yang et al., 2014, p. 884). "Implementation of a clinical pathway (CP) significantly reduced

				disease was diagnosed after admission.	according to 30 days in-hospital mortality, in-hospital mortality, and the modified Rankin score during a single length of stay Instruments: National Institute of Health Stroke Scale (NIHSS) Modified Rankin score tool Data Analysis: Kruskal-Wallis test for continuous variables. Fisher exact test for categorical variables. Post hoc analysis was performed by the Dunn procedure for continuous varioables. Survival curves were obtained by Kaplan-Meier analysis. The log-rank test was performed for comparisons among 4 groups.	the time interval from patient arrival in the ED to evaluation and delivery of thrombolytic treatment. In addition, it led to an increase in the number of patients treated with thrombolytic agents" (Yang et al., 2014, p. 885). "The rates of treatment with IV-tPA were not affected by off-day and weekend hours" (Yang et al., 2014, p. 886). "A systematic and well-organized alert system could sufficiently attenuate disparities in time intervals irrespective of arrival time in the ED" (Yang et al., 2014, p. 887). "Off-hour and weekend effects might be influenced by many factors, including discontinuity of care, inadequate staffing, reduced availability of interventions, and an overall reduction in supervision of patients during off-hours and weekends" (Yang et al., 2014, p. 887).
11	Speirs, L., & Mitchell, A. (2015). Meet Me in Computed Tomography Suite: Decreasing Tissue Plasminogen Activator Door-to-Needle Time for Acute Ischemic Stroke Patients: JEN. *Journal of Emergency Nursing, 41*(5), 381-386.	Controlled Trial without Randomization Purpose: Not outwardly discussed; but stated measured objectives include door-to-CT time, door-to-CT result time, and door-to-needle time (DTN) as a result of implementing the direct to CT approach and improving workflow.	III	Sample: 34 patients received tPA and had door-to-CT, door-to-CT result, and DTN times monitored. Setting: Part of a multistate health care system located in a large metropolitan area. The facility treats 1,000 to 1,200 TIA and stroke patients per year and averages 450 to 500 stroke alerts annually. Inclusion & Exclusion Criteria: Patients eligible to receive tPA between the study	Methods: Performed a literature review compared to their current processes to find areas that were inefficient. Implemented the direct to CT approach and highlighted comleting other tasks such as monitor attachment, second IV line, and assessment simultaneously during the period in between the CT scan and receiving the results. Instruments: None discussed.	"Since the introduction of intravenous (IV) recombinant tissue plasminogen activator (tPA) as a treatment for ischemic stroke patients, stroke has declined from the third to the fourth leading cause of death in the United States" (Speirs & Mitchell, 2015, p. 381). "For each minute during which a large-vessel ischemic stroke is untreated, 1.9 billion neurons and 13.8 billion synapses are lost. For each hour the stroke is untreated, the same neuronal loss develops that would occur in 3.6 years of normal aging" (Speirs & Mitchell, 2015, p. 381). "Current recommendations are to administer IV tPA within 60 minutes of arrival to the emergency department" (Speirs & Mitchell, 2015, p. 381).

				period of June 2013 through June 2014.	Data Analysis: Specific modes of analysis not discussed, only stated time reduction results.	"For every 15-minute reduction in door-to-needle (DTN) time, the risk-adjusted in-hospital mortality rate decreases by 5%" (Speirs & Mitchell, 2015, p. 381). "No pre-notification of the impending arrival of a stroke patient, a protracted triage process, location of the CT scanner outside the emergency department, lack of a dedicated stroke team process, and standardized stroke treatment protocols are hurdles to timely stroke identification and tPA administration" (Speirs & Mitchell, 2015, p. 381). "Most time is lost in the prehospital setting primarily because patients delay seeking medical attention" (Speirs & Mitchell, 2015, p. 382). "Creating and training stroke teams, implementing preapproved standardized treatment protocols, obtaining administrative support, and monitoring performance are associated with early tPA use" (Speirs & Mitchell, 2015, p. 382). "3 barriers associated with delayed tPA administration: (1) inefficient patient flow, (2) serial processing of multiple tasks, and (3) delayed laboratory results for patients taking anticoagulants" (Speirs & Mitchell, 2015, p. 382). "After streamlining the approach by taking the patient directly to the CT suit on arrival, performing required tasks simultaneously, and adopting POC testing for patients who have undergone anticoagulation, the average DTN time decreased from 60 to 39 minutes and the percentage of patients receiving tPA increased from 52% to 78%" (Speirs & Mitchell, 2015, p. 382). "A 'stroke box' fully stocked with all necessary supplies for tPA administration is available in the emergency department" (Speirs & Mitchell, 2015, p. 383). "Postponing nonessential components of care until after completion of the CT scan does not appear to result in any harm to the patient or interfere with routine CT operations" (Speirs & Mitchell, 2015, p. 385).

12	Kamal, N., Jeerakathil, T., Stang, J., Liu, M., Rogers, E., Smith, E. E., … Hill, M. D. (2020). Provincial Door-to-Needle Improvement Initiative Results in Improved Patient Outcomes Across an Entire Population. *Stroke, 51*, 2339–2346.	Pre-Post Cohort Study Purpose: "This cohort study looks at the effect on patient outcomes of an Improvement Collaborative intervention that aimed to lower DNT for thrombolysed ischemic stroke patients across an entire population" (Kamal et al, 2020, p. 2340).	IV	Sample: 2048 patients received thrombolysis in the pre-period from July 1, 2007 to March 31, 2015, and 689 patients in the post-period from October 1, 2016 to December 31, 2017. Setting: Conducted over 10 years in the Canadian province of Alberta with 17 designated stroke centers. Inclusion & Exclusion Criteria: Acute ischemic stroke patients treated with alteplase in the Canadian province of Alberta were included. Data collected during the implementation of the intervention from April 1, 2015 to September 30, 2016 were excluded. Strokes that occurred in a hospital setting were excluded. Patients who were not residing in Alberta at the time of the stroke onset were excluded.	Methods: An Institute for Healthcare Improvement – Improvement Collaborative methodology was used to lower DNTs across Alberta. This consisted of the recruitment of interdisciplinary teams from all the stroke centers, 3 face-to-face workshops, site visits to all stroke centers, 10 webinars, data audit, data feedback, and a closing celebration. Instruments: Quality Improvement and Clinical Research (QuICR) registry and the Alberta Provincial Stroke Strategy were used to collect data. National Institutes of Health Stroke Scale (NIHSS). The National Ambulatory Care Reporting System. Data Analysis: The x2 test was used for the analysis of categorical outcomes, and Wilcoxon rank-sum test was used for analysis of continuous outcomes. Logistic regression was used for the analysis of categorical outcomes, and quantile regression was used for the analysis of continuous outcomes. A zero inflated negative binomial regression model was used for	"The US Target Stroke initiative has set the target DNT to a median of 45 minutes" (Kamal et al., 2020, p. 2339). "The DNT dropped from a median of 70 minutes to 39 minutes for those patients who received alteplase within 4.5 hours of onset" (Kamal et al., 2020, p. 2341). "The adjusted percentage of patients discharged home from acute care increased from 46.5% to 59.5%, [...] the adjusted in-hospital mortality decreased from 14.5% to 10.5%" (Kamal et al., 2020, pp. 2341-2). "The median 90-day home time increased from 39 days to 71 days" (Kamal et al., 2020, p. 2342).

					adjustments for covariates.	
13	Elder, K. G., Lemon, S. K., & Costello, T. J. (2015). Increasing compliance with national quality measures for stroke through use of a standard order set. *American Journal of Health-System Pharmacy : AJHP : Official Journal of the American Society of Health-System Pharmacists*, *72*(11 Suppl 1), S6–S10.	Randomized Controlled Trial with Retrospective Audits Purpose: "Results of a study to determine the impact of physician use of a medication order set on compliance with national quality standards for acute stroke treatment are presented" (Elder et al., 2015, p. S6).	II	Sample: A total of 120 patient charts were reviewed. 70 patients from hospital A from January 1, 2007 to August 31, 2011. 30 patients from hospital B and 20 from hospital C both from September 1, 2009 to August 31, 2011. Setting: Three certified primary stroke centers within a large healthcare system. Inclusion & Exclusion Criteria: Patients were excluded if they were pregnant, less than 18yrs of greater than 89yrs of age, incarcerated, or had hemorrhagic stroke.	Methods: A uniform medication order set was created by a multidisciplinary team of stroke experts from the three hospitals. Primary objective was to determine if the use of a predifined order set resulted in adherence to all eight required standards of stroke care. The secondary objectives were to determine rates of adherence to specific standards, the impact of standard adherence on length of hospitalization, and the discharge disposition of patients. Instruments: A random number generator was used to select patients from the three hospitals. Data Analysis: Chi-square and Fisher's exact tests were used to analyze adherence to standards. The Mann-Whitney U test was used for comparisons of data. Statistical analyses were performed using Microsoft Excel and SPSS, version 19.0.	"Stroke is still the fourth leading cause of death nationwide" (Elder et al., 2015, p. S6). "Almost 90% of strokes are ischemic" (Elder et al., 2015, p. S6). "Current guidelines for ischemic stroke advocate the use of intravenous tissue plasminogen activator, the early use of antithrombotics, venous thromboembolism prophylaxis, anticoagulation in patients with atrial fibrillation, and lipid-lowering therapy" (Elder et al., 2015, p. S6). "Individual patients who were treated without physician use of the order set were more than twice as likely as those in the comparator group to receive care that was not in compliance with at least one of the eight mandatory quality standards" (Elder et al., 2015, p. S6). "There are eight mandatory standards, which require that the patient receive (1) VTE prophylaxis, (2) anticoagulation therapy for atrial fibrillation or flutter, (3) thrombolytic therapy, and (4) antithrombotic therapy by the end of hospital day 2; are discharged on (5) statin therapy and (6) anti-thrombotic therapy; and receive (7) stroke education and (8) assessment for rehabilitation" (Elder et al., 2015, p. S7). "Standing orders as a part of a multidisciplinary acute stroke treatment program have been shown to decrease length of stay and cost in stroke patients" (Elder et al., 2015, p. S7). "The Brain Attack Coalition recommends using written care protocols when treating patients with stroke and including the protocols within an electronic medical record (EMR) when feasible" (Elder et al., 2015, p. S7). "Of those physicians who used the order set, 94% were neurologists" (Elder et al., 2015, p. S8). "A patient treated without the order set was 2.4 times more likely to receive care that was not in compliance with all eight mandatory

						standards" (Elder et al., 2015, p. S8). "The updated recommendations for primary stroke centers suggest efforts to incorporate order sets into the EMR whenever possible" (Elder et al., 2015, p. S9).
14	Tran, D., Zhu, Z., Shafie, M., Abcede, H., Stradling, D., & Yu, W. (2019). Three Easily-Implementable Changes Reduce Median Door-to-Needle Time for Intravenous Thrombolysis by 23 Minutes. *BMC Neurology*, *19*(1), 1-6.	Controlled Trial without Randomization Purpose: "We investigated the effect of a simple quality improvement initiative on DNT for IVT" (Tran et al., 2019, p. 1).	III	Sample: 90 patients in the pre-intervention group from January 2018 to December 2014 and 136 patients in the post-intervention group from January 2016 to December 2017. Setting: University of California Irvine Certified Stroke Center between January 2013 and December 2017. Inclusion & Exclusion Criteria: Consecutive patients with LKWT within 4.5hr were evaluated. Exclusion criteria was not discussed.	Methods: An improvement protocol was initiated which included three parts and allowed the stroke team to (1) manage hypertension in the emergency room, (2) make the decision for IVT before getting blood test results unless the patient was taking oral anticoagulants, and (3) give IVT in the CT suite. Instruments: National Institutes of Health Stroke Scale (NIHSS) Modified Rankin Scale (mRS) Data Analysis: t-test or Wilcoxon rank-sum test were used for continuous variables and x2 test for categorical variables. Multivariate logistic regression analysis was used to compare the 2 groups. Analyses were performed using SPSS software – IBM Version 23.	"Intravenous thrombolysis (IVT) with tissue-type plasminogen activator (tPA) is the proven medical therapy for acute ischemic stroke (AIS), with faster administration resulting in better outcomes" (Tran et al., 2019, p. 1). "Acute ischemic stroke is characterized by the sudden loss of blood circulation to an area of the brain, resulting in a corresponding loss of neurologic function" (Tran et al., 2019, p. 2). "The median DNT was reduced by 23min from 63 minutes in the pre-intervention group to 40 minutes in the post-intervention group" (Tran et al., 2019, p. 3). "Significantly more patients in the post-intervention group received IVT within 60min (81.6% vs. 46.7%) and 45min (64.0% vs. 17.8%) than in the pre-intervention group" (Tran et al., 2019, p. 3). "Uncontrolled hypertension is one of the most frequently reported factors causing delayed DNT [...] [and] was associated with more than 30min delay in DNT" (Tran et al., 2019, p. 3). "Waiting for blood testing results is another common reason for delay up to 60min in some eligible patients" (Tran et al., 2019, p. 4).
15	Yoo, J., Sohn, S.-I., Kim, J., Ahn, S. H., Lee, K., Baek, J.-H., Kim, K., Hong, J.-H., Koo, J., Kim, Y. D., Kwak, J., Nam, H. S., & Heo, J. H. (2018).	Retrospective Cohort Study Purpose: "We investigated whether the time from arrival at ED to various care steps differed between patients with minor and non-minor stroke	IV	Sample: 356 patients received IV tPA treatment during the study period of July 2015 through December 2016 91 patients were classified in the minor stroke group and 265 patients	Methods: This study was performed retrospectively using registry data of prospectively enrolled patients. Primary outcomes assed were door-to-needle time, door-to-notification time, door-to-imaging	"The rapid administration of IV tPA is crucial for improving the outcomes of acute stroke treatment" (Yoo et al., 2018, p. 53). "The initial diagnosis at triage, and the behavior and actions of the hospital personnel who are involved in acute stroke care in the ED may differ according to the stroke severity" (Yoo et al., 2018, p. 53).

	Delayed Intravenous Thrombolysis in Patients with Minor Stroke. *Cerebrovascular Diseases (Basel, Switzerland)*, *46*(1–2), 52–58.	who were treated with intravenous tissue plasminogen activator (IV tPA) during a 1.5 year period in 5 hospitals. (Yoo et al., 2018, p. 52).		were classified in the non-minor stroke group. Setting: 5 University hospitals in Korea. Inclusion & Exclusion Criteria: Consecutive patients who received IV tPA during a 1.5 year period in 5 hospitals were included.	time, notification-to-imaging time, and imaging-to-needle time. Instruments: National Institutes of Health Stroke Scale (NIHSS). Modified Rankin Scale (mRS). Get With The Guidelines – STroke program database. Data Analysis: Time intervals were compared using chi-squared tests or independent Student t tests. Time intervals were tested with Wilcoxon rank-sum tests. All statistical analyses were performed using R version 3.4.1.	"The door-to-needle time was significantly longer in the minor stroke group than it was in the non-minor stroke group (43min vs. 37min)" (Yoo et al., 2018, p. 54). "Door-to-notification time (7min vs. 5min) and door-to-imaging time (20min vs. 16min) were significantly longer in the minor stroke group than they were in the non-minor stroke group" (Yoo et al., 2018, p. 54). "The initial procedures performed in the ED might be delayed in stroke patients with mild neurologic deficits" (Yoo et al., 2018, p. 55). "The rapid diagnosis of stroke may be occasionally difficult in patients with isolated symptoms or minor neurologic deficits. This may occur more frequently in the ED where nurses and ED physicians are engaged in the initial steps of triage" (Yoo et al., 2018, p. 57). "Misdiagnosis at the initial presentation to the ED might cause delays in the subsequent steps" (Yoo et al., 2018, p. 57). "The actions of hospital staff in the ED may be influence by the conditions of the patients and the status of the ED [...] it is likely that ED personnel respond more rapidly to patients with severe stroke than they do those with minor stroke" (Yoo et al., 2018, p. 57). "Educational programs aimed at the ED staff should inform them on how to recognize stroke symptoms and emphasize the need for rapid treatment in patients with minor stroke" (Yoo et al., 2018, p. 57).