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Target: Stroke Best Practice of Direct Transport to Computed Tomography and Its Impact on Stroke Treatment Times

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Target: Stroke Best Practice of Direct Transport to Computed Tomography and Its Impact on Stroke Treatment Times

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Nursing Practice

by

Annabelle Braun

2020

ABSTRACT OF THE DISSERTATION

Target: Stroke Best Practice of Direct Transport

to Computed Tomography and Its Impact on

Stroke Treatment Times

by

Annabelle Braun

Doctor of Nursing Practice

University of California, Los Angeles, 2020

Professor Jo-Ann Eastwood, Chair

Background: Every forty seconds a stroke occurs and every four minutes someone in the United States dies from a stroke. Strokes are responsible for taking 140,000 lives every year, which is one out of every twenty deaths in the United States (U.S.) (American Heart Association [AHA], 2019; Centers for Disease Control and Prevention [CDC], 2019). The CDC identified "stroke" as the 5th leading cause of death and one of the leading causes of long-term disability in the U.S. The physical and social complications of stroke can be translated into healthcare dollars. The cost of stroke in the U.S. is estimated at $34 billion annually and the cost is expected to triple to $184.1 billion annually by 2030. Objective: This evidence-based quality improvement (QI) project was to determine if education and application of the Target: Stroke Best Practices can influence direct transport to computed tomography (CT) scan transport, as compared to current practice and improve door-to-needle (DTN) times within 30 minutes in at least 50% of patients within a three-month period. Setting and Sample was a 552-bed community hospital located in Southern California. This project was a single site, retrospective, chart review comparing two sample groups, pre and post an educational intervention (Group 1, 2019), Group 2 (2020). Analysis: A paired t-test was performed to compare Group 1's mean door-to-CT scan times and DTN times with Group 2's mean door-to-CT scan and DTN times. Results: Group 2's mean door-to-CT time significantly decreased by 18 minutes ($P < .001$). Group 2's mean DTN time also decreased significantly by 21 minutes ($P < .001$) when compared to Group 1. Conclusions: The implementation of stroke education sessions and Target: Stroke Best Practices of direct to CT scan were associated with improved door-to-CT times and DTN times. Future research is needed to explore the functional outcomes at 30- and 90-days post discharge. Keywords: acute ischemic stroke, DTN time, door-to-CT time, patient outcomes.

The dissertation of Annabelle Braun is approved.

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2020

Dedication

In memory of my grandfather. My first and favorite patient. There is not a day that goes by that I do not think about you and your singing of "You are my sunshine"

For my parents, who raised me to be strong and to never give up in my accomplishing my goals and dreams. Thank you for sacrificing so much for our family

For my daughters, you are my heart, happiness and sunshine to my cloudiest days. I hope to inspire both of you to pursue your goals and dreams

For Bill, thank you for always believing in me throughout this journey. I could not have done this without you, and I am forever grateful for your love and support

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List of Acronyms

Name	Acronym
Quality Improvement	QI
Door-to-Needle	DTN
American Heart Association	AHA
Centers for Disease Control and Prevention	CDC
Computed Tomography	CT
Tissue Plasminogen Activator	tPA
Acute Ischemic Stroke	AIS
Emergency Department	ED
Deoxyribonucleic Acid	DNA
Emergency Medical Services	EMS
Electronic Medical Record	EMR
Electrocardiograms	EKG
Evidence-based Practice	EBP
Chest Radiogram	CXR
Table of Evidence	TOE
Stroke Response Team	SRT
Balance, Eyes, Face Drooping, Arm Weakness, Speech Difficulty, Time to call 911	BE-FAST

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Chapter 1

Introduction

Every forty seconds, a stroke occurs and every four minutes someone in the United States (U.S.) dies from one (Benjamin et al., 2019). Strokes are responsible for taking 140,000 lives every year; this accounts for one out of every twenty deaths in the U.S. (American Heart Association [AHA], 2019; Centers for Disease Control and Prevention [CDC], 2019). The CDC lists stroke as the fifth leading cause of death and one of the leading causes of long-term disability in the U.S. (CDC, 2017).

The physical and social complications of stroke can be translated into healthcare dollars. The cost of stroke in the U.S. is estimated at $34 billion annually (Benjamin et al., 2019). The cost is expected to triple to $184.1 billion annually by 2030 (CDC, 2019; Benjamin, 2019). The largest increase in expenses occurs within the 65 to 79-year-old age group. The major components of healthcare costs are related to health care services, medications, and missed days of work (AHA, 2019). The personal and societal burden of the sequelae of stroke can be significantly reduced with early identification and timely treatment.

Types of Strokes

There are two types of stroke, ischemic and hemorrhagic. An ischemic stroke occurs when a blood clot develops within an artery, impedes blood flow to the brain, and causes destruction of brain cells due to lack of oxygen (CDC, 2019, Mozzafarian et al., 2016; Benjamin et al, 2019). Hemorrhagic stroke occurs when a blood vessel in the brain ruptures and begins bleeding into the brain and surrounding tissue (CDC, 2019). Early identification of the type of stroke is critical to elicit timely treatment and to avoid further harm to the patient.

Ischemic strokes comprise 87% of strokes. The imaging test used to identify an ischemic stroke is a CT scan. Diagnosing an ischemic stroke by CT scan is crucial for the timely administration of the thrombolytic medication tissue plasminogen activator (tPA) which is given intravenously. The national recommended timeline to perform the CT scan for patients with acute ischemic stroke (AIS) is within 25 minutes of patient arrival to the Emergency Department (ED) (AHA, 2019).

To interrupt brain ischemia and cell death, early reperfusion therapy with tPA is of critical importance (Lee et al., 2018). The medication is an enzyme produced by recombinant deoxyribonucleic acid (DNA) technology. When tPA is infused into the body's circulatory system it rapidly dissolves the blood clot so that blood flow can be restored, limiting ischemic brain damage (Cheng & Kim, 2015). Research shows that the early administration of tPA is associated with lower in-hospital mortality and morbidity, greater functional recovery from a stroke, and decreased length of hospital stay (Fonarow et al., 2014; Kamal et al., 2017; Xian et al., 2017; Tan et al., 2018, Bhatt et al., 2019).

While tPA has been shown to be beneficial in the treatment of ischemic stroke, it is absolutely contraindicated in patients with a hemorrhagic stroke (Fugate & Rabinstein, 2015). A CT scan is the diagnostic test to determine if a patient has a hemorrhagic stroke. A major complication of tPA administration is an intracranial hemorrhage, which can further increase bleeding in the brain. An intracerebral hemorrhage is a life-threatening disease and the 30-day mortality ranges from 35% to 52% with only 20% of patients expected to have a full functional recovery at six months. Approximately half of this mortality occurs within the first 24 hours (Elliott & Smith, 2010). Established treatment to reverse post tPA hemorrhage includes administration of blood products such as cryoprecipitate, fresh frozen plasma, and platelets

(AHA, 2019). Therefore, the evidence-based goals of treatment for ischemic stroke include the early recognition of stroke, identifying what type of stroke and the administration of tPA within 30 minutes of arrival to the ED (door-to-needle time).

American Heart Association's Target: Stroke Initiative

In 2010, AHA launched the Target: Stroke initiative to improve the treatment and outcomes of stroke. Hospitals which participated in Get with the Guidelines (GWTG) committed to reaching the Target: Stroke performance goal of treating at least 50% or more of eligible patients with tPA within 60 minutes from arriving at the emergency department [ED] (AHA, 2019). In 2014, Fonarow and colleagues (2014) reviewed the data of over 71,169 patients with acute ischemic stroke [AIS] from 1,030 hospitals participating in the GWTG initiative to determine if the recommended guidelines improved door-to-needle [DTN] times. The results of the data review revealed that the median DTN times for tPA administration decreased from 77 minutes during the pre-intervention period to 67 minutes during the post-intervention period. In addition, the percentage of AIS patients treated with tPA increased from 30% to 50% and in-hospital mortality improved significantly from 9.93% to 8.25%. These significant results motivated the Phase II, Target: Stroke in 2015. In turn, this resulted in the Phase II goal for DTN times under 60 minutes from 50% to 75% of patients with AIS (AHA, 2019).

In 2018, the Target: Stroke Phase III project raised the bar further by setting more aggressive targets for tPA administration to improve stroke patient outcomes. These updated guidelines recommended achieving DTN times within 30 minutes in at least 50% or more of AIS patients (AHA, 2019). Many certified comprehensive stroke hospitals across the nation are actively working to meet the AHA's Target: Stroke Phase III time metric intervals to achieve DTN times under 30 minutes (AHA, 2019) (see Appendix A).

Target: Stroke Best Practices

The antecedents for this evidence-based QI project were influenced by the AHA's Target: Stroke initiative, which began with an interdisciplinary work group of experts. The work group was comprised of members from the AHA and experts from emergency medicine, stroke neurology, quality improvement, nursing, emergency medical services (EMS), and hospital administration (AHA, 2019). The multi-disciplinary team performed a critical appraisal and systematic review of the published literature on AIS and DTN times. The researchers identified ten 'Best Practices' to achieve faster DTN times which include: EMS notification, stroke tools, rapid triage protocol, single activation system, rapid acquisition and interpretation of brain imaging, rapid laboratory testing, pre-mixing of tPA, rapid access and administration of tPA, team-based approach, and prompt data feedback (see Table 6.1).

The most recent 2018 Target: Stroke Best Practices have added two additional steps for a total of 12 'Best Practices,' which are the attachment of a clock or timer to the patient bed and direct transport to CT Scan. The case hospital was currently performing 10 of the 12 best practices (see Table 7.1). The Project Leader implemented the newly added best practice of direct transport to CT scan for the rapid and correct diagnosis of ischemic stroke to expedite the safe administration of tPA. This new best practice has shown to significantly improve DTN times.

Statement of the Problem

A comprehensive stroke community hospital located in Orange County continued to have DTN times greater than 30 minutes putting patients with AIS at risk. From July to September 2019, an electronic medical record (EMR) review of 48 AIS patients treated with tPA showed that only 15 (31%) of the 48 patients received tPA in under 30 minutes. The remaining 33 (69%)

out of the 48 patients received tPA within the range of 31 minutes to 85 minutes from arrival to the ED (see Appendix B).

To determine the reason for the treatment delay, further review of the EMR documentation revealed that 15 of the 48 patients treated with tPA also had a delay in obtaining the necessary CT scan to confirm ischemic stroke. This a critical step in the stroke protocol. The times from admission to CT scan for the 15 patients ranged from 30 to 45 minutes. In all cases, several unnecessary assessments and diagnostic tests were identified which led to the delay in patient transport to the CT scan. Examples of unnecessary procedures and tests performed in the ED prior to patient transport to CT scan included: 1) insertion of secondary intravenous line, 2) electrocardiograms [EKG] and chest radiograms [X-ray], and 3) blood draws for laboratory tests.

The delay in obtaining the CT scan then resulted in delayed treatment with tPA. National guidelines recommend CT scan to be initiated within 15 minutes of patient admission (AHA, 2019). Thus, there was an imperative need to review the literature and implement an evidence-based stroke protocol to decrease DTN times to under 30 minutes in patients with AIS at the case hospital.

PICOT Question

The above clinical problem led to the development of the following PICOT question for this quality improvement project: In adult patients with AIS (P) will education of the Target: Stroke Best Practice (I) influence direct to CT scan transport, as compared to current practice (C) and improve DTN times (O) within 30 minutes in at least 50% of patients within a three-month period (T)?

Project Goals

The major goal of this QI project was to achieve a significant reduction in DTN times from pre- to post-intervention based on evidence-based research and national standards. Overall project goals were to potentially increase patient safety, quality of care, increase compliance with national performance standards, and reflect positive outcomes for the patient, staff, and organization.

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Chapter 2

Theoretical Framework

The theoretical framework that was used to address the clinical practice issue of delays in diagnostic CT scans resulting in lengthy door-to-needle times was the IOWA Model-Revised (Buckwalter et al., 2017) (see Appendix C). The IOWA Model-Revised is a commonly used framework for the implementation of evidence-based practice (EBP). This model provided a relevant framework to which the PICOT question can be applied to implement the best practice of direct transport of AIS patient to CT scan resulting in improved door-to-needle times. In addition, the model was chosen for this QI project because it emphasized the increased adoption of EBP, enhanced interprofessional collaboration, and a systemic process that guides the EBP change into practice (Buckwalter et al., 2017).

Phases of the IOWA-Model-Revised Process

The first step of the model was the identification of triggering issues and opportunities (Buckwalter et al., 2017). The revised model contains five triggers; clinical or patient identified issue; data/new evidence; philosophy of care; organization, state, or national initiative; and regulatory agency requirements/regulations (Buckwalter et al., 2017). All five triggering issues aided in identifying the clinical problem of door-to needle-times in AIS patients. Thus, the first trigger was the "clinical identified issue" that was detected by the ED nursing staff regarding stroke treatment delays. The second trigger of "data/new evidence" review revealed that only 15 (31%) of the 48 patients received tPA treatment consistent with the 2019 nationally recommended guidelines of DTN time of under 30 minutes in at least 50% of AIS patients. In addition, AIS patients were not receiving safe, quality, and cost-effective care which is part of the Philosophy, Vision, and Mission statement of this institution. Thus, the third trigger of "philosophy of care" also influences the identification of this clinical problem. The case hospital is also a certified Comprehensive Stroke Center. A Comprehensive Stroke Center represents the highest certification for those hospitals that have specific abilities to receive and treat the most complex stroke cases. In addition, EMS routing protocols dictate where the most complicated stroke patients can be treated and Comprehensive Stroke Centers are best equipped to provide the specialized care that can lead to better outcomes (AHA, 2019, The Joint Commission, 2019). Failure to comply with the AHA's quality metrics of Get with the Guidelines-Stroke measures places the organization at risk for losing their Comprehensive Stroke Certification. Thus, the fourth and fifth trigger of "organization initiative" and "regulatory requirements" could result in loss of hospital revenue and stroke center designation.

The second step of the model was to "state the question or problem." This step encourages users of the model to specifically focus on the PICOT question which is to implement the AHA's Target: Stroke best practice of direct transport to CT scan improve door-to-needle times within 30 minutes in at least 50% of AIS patients. An excel log sheet (see Table 8.1) for each patient treated with tPA will be created to identify if the acute code stroke documentation form (see Appendix D) action steps were completed and if the actual times met the recommended time targets.

The next steps of the model required the Project Leader to consider the competencies and skills that are needed to plan, conduct and evaluate the EBP change project (Buckwalter et al., 2017), which constitutes step three, "forming the team." The model was a good fit for this project because it provided a framework to conduct an evidence based interdisciplinary practice change project culminating with step four of the model, which included: 1) review of the current literature as synthesized in the Table of Evidence (TOE) (see Table 9), 2) development and implementation of the intervention (Methods), 3) evaluation of the outcomes to ensure quality, safety and cost-effective care per the Comprehensive Stroke Core Measures (see Appendix E). The Project Leader needed to integrate science and participation from many disciplines such as medicine, nursing, pharmacy, radiology, laboratory and administration, in order to develop, implement and evaluate new practice approaches (American Association of Colleges of Nursing, 2006) (Buckwalter et al., 2017). Each department identified the current barriers of implementing the project of direct transport to CT scan and worked collaboratively on the solution process.

The fifth step of the model was to pilot the change in practice (Buckwalter et al., 2017). The intervention was to modify the current stroke protocol to provide direct transport to CT scan to achieve DTN times under 30 minutes. The sixth step of the model was to integrate and sustain the new intervention (direct transport to CT scan) into practice (Buckwalter et al., 2017). This required the Project Leader to work with several departments to hardwire and sustain the change into practice within the ED and organization.

The final step of the model was dissemination of the results (Buckwalter et al., 2017). The results of the pilot were disseminated both internally and externally. The Project Leader mentored key team members in the dissemination process. Internal dissemination of the project results took place at key forums within the hospital (i.e., staff huddles, department meetings, and grand rounds). In addition, a variety of communication methods were used to disseminate the project results such as emails, stroke newsletter, newsletters, and tip sheets. External dissemination of the project results such as by abstract submission, podium presentation and article publications are currently in process of being reviewed and discussed by the Project Leader and SRT members.

In summary, the IOWA Model-Revised was a perfect fit for this DNP Scholarly Project because it linked evidence-based practice changes within the system. The model also emphasized expansion of piloting, implementation, patient engagement and sustaining the practices change to promote excellence in stroke health and outcomes.

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Chapter 3

Review of Literature

A comprehensive review of the literature between the years of 2014 to 2019 was conducted for this project using PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), and Cochrane databases. The rationale in choosing these databases was because of the vast number of peer-reviewed journals and publications in the disciplines of nursing, medicine, and allied health. The search process involved the use of both medical subject heading (MeSH) and free-text search terms to maximize the retrieval of citations. The following search terms were used: "ischemic stroke or acute strokes," and "door-to-needle times" and "door-to-CT times" and "Target-Stroke."

The inclusion criteria involved primary research studies of any design such as the randomized controlled trials, quasi-experimental, pilot and feasibility studies, prospective and retrospective studies. Other inclusion criteria were a) published within the last five years, b) written in English language, c) focused on adult population from 18 years of age and above. The exclusion criteria involved review articles and studies outside Australia, Europe, and the U. S. In addition, research that involved other factors that cause delays besides door-to-needle times or door-to-CT times were excluded from the search.

The initial search yielded 94 articles: (a) 33 from CINAHL, (b) 49 from PubMed, and (c) 12 from Cochrane Database with only seven that answered the PICOT question and were published in the last five years. Of the seven articles, five studies were single site, retrospective in design (Bershad et al., 2015; Bhatt et al., 2019; Caputo et al., 2017; Tan et al., 2018; Threlkeld et al., 2017). Of the remaining two studies, one study was a single site, prospective cohort study

(Kaal et al., 2017) and the other study was a cross-sectional study survey of over 888 hospitals (Xian et al., 2017). Six of the seven studies implemented stroke protocols to facilitate direct transport of AIS patients to the CT scan. All seven of the research articles had DTN times as an outcome measure (refer to TOE).

Review of Literature Design and Inclusion Criteria

Xian and colleagues (2017) reported on a survey of over 888 Get with the Guideline-Stroke hospitals to determine which Target: Stroke best practices were used to reduce door-to-needle times. Several of the studies implemented stroke protocols to facilitate direct transport of AIS patients to the CT scan (Bershad et al, 2015; Caputo et al., 2017; Tan et al., 2018; Kamal et al.2017; Threlkeld et al., 2017; Bhatt et al., 2019). A common outcome of the reports included DTN times and door-to-CT times as a primary or secondary outcome measure. The population included adults at or over 18 years with sample sizes ranging from 274-16,901 AIS patients receiving tPA. Similarly, all subjects were admitted through the ED either by EMS ambulance or “walk in” (Bershad et al., 2015; Bhatt et al., 2019; Caputo et al., 2017; Kamal et al., 2017; Tan et al., 2018; Threlkeld et al., 2017; Xian et al., 2017).

Several of the study samples contained more males than females and with a mean age of 68 to 71 years (Caputo et al., 2017; Kamal et al., 2017; Tan et al., 2018; Bhatt et al., 2019). The case hospital stroke patient demographics also included a higher percentage of male patients (53% males, 47% females) with a mean age of 70-72 years. Two of the studies revealed that White and Hispanic ethnicities represented greater than 50% of the stroke patient demographics, which is a similar demographic as the case hospital (Threlkeld et al., 2017; Bhatt et al., 2019). Most of the studies implemented interventions that decreased DTN times and reduced door-to CT times. The interventions common to six of the studies were: 1) EMS call notification to ED,

2) direct transfer to CT scan 3) deferring laboratory and diagnostic tests, 4) administration of IV-tPA in CT scan ((Bershad et al, 2015; Caputo et al., 2017; Tan et al., 2018; Kamal et al.2017; Threlkeld et al., 2017; Bhatt et al., 2019). Two of the studies implemented a stroke protocol for direct transport to CT scan upon patient arrival to the ED by initiating the following: 1) eliminating transfer of AIS patients to an ED room and directly transferring to CT scan, 2) performing an abbreviated neurological assessment instead of a complete assessment, 3) deferring laboratory tests (4) deferring diagnostic tests 4) postponing nursing procedures (insertion of secondary IV line) until after CT scan (Bershad et al., 2015, Caputo et al., 2017) which resulted in the reduction of median door-to-CT times of 12 to 20 minutes. In another study, investigators implemented eleven interventions in a stepwise fashion over a seven-year time period revealing three interventions that produced the greatest influence on reduction in DTN times. These interventions included: 1) EMS call notification to ED on AIS patient arrival, 2) dedicated stroke pharmacist in the ED, 3) storing of tPA in CT scan and administering tPA to the patient in CT scan (Threlkeld et al., 2017).

Several studies implemented early (in field) EMS call notification to the ED regarding arrival of the AIS patient (Bershad et al., 2015; Tan et al., 2018; Kamal et al.2017; Threlkeld et al., 2017; Bhatt et al., 2019). This enabled clinical staff to meet the patient at the ED entrance and facilitate rapid transfer from the ambulance to the CT scan. Only three of the studies implemented pre-mixing of tPA prior to the CT scan results and administered tPA to patients in the CT scan (Caputo et al., 2017; Kamal et al., 2017; Bhatt et al., 2019). Six research studies that implemented at least 9 of the 12 Target: Stroke Best Practices resulted in a significant reduction in DTN times (Bershad et al., 2015; Caputo et al., 2017; Kamal et al., 2017; Threlkeld et al., 2017; Tan et al., 2018; Bhatt et al., 2019).

Each of the studies reported a significant ($P \leq 0.05$) improvement in the outcome of door-to-needle times (Bershad et al., 2015; Bhatt et al., 2019; Caputo et al., 2017; Threlkeld et al., 2017; Kamal et al., 2017; Tan et al., 2018; Xian et al., 2017), with many reporting a reduction of median DTN times of 26 to 37 minutes. This success was attributed to using a stroke protocol that consisted of the following: 1) EMS call notification, 2) direct transport of patient to the CT scan, 3) administration of tPA in the CT scan (Kamal et al., 2017; Threlkeld et al., 2017; Tan et al., 2018; Bhatt et al., 2019).

Since six of the studies were single site and retrospective in design, the advantages can include: 1) quicker, cheaper and easier to design, 2) can address diseases and identify potential risk factors, 3) not prone to loss of follow up, and 4) may be used as the initial study to generate a hypothesis to be studied further by prospective studies (Sedgwick, 2014). In addition, all seven of the research studies reported significant ($P \leq 0.05$) improvement in the outcome of door-to-needle times. In summary, the evidence-based interventions common to all studies that resulted in improved DTN times included: 1) EMS call notification to ED, 2) direct transfer to CT scan 3) deferring laboratory tests, 4) deferring diagnostic tests, 5) administration of tPA in CT scan.

Limitations on Review of Literature

Six of the seven studies were single site and retrospective in design; hence, results of the studies may not be characteristic of the general population and prone to selection bias. In addition, one of the studies was a survey of hospitals regarding reasons for delay. Since data were self-reported by hospitals, under or over reporting could affect the validity and reliability of findings (Xian et al., 2017).The lack of randomization in the studies also limits the ability to establish causation of the interventions on the outcome. Instead, the results of the studies suggest an association i.e., that the interventions could have contributed in some way to the reduced DTN times (Bershad et al., 2015; Caputo et al., 2017; Threlkeld et al., 2017; Kamal et al., 2017; Tan et al., 2018; Bhatt et al., 2019).

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Chapter 4

Methods

Project Design

The design of the QI project was a single site, retrospective chart review of two sample groups over two different time periods: Group 1 (January 20, 2019 to March 20, 2019) and Group 2 (January 20, 2020 to March 20, 2020). These sample groups were patients who were admitted to the case hospital with the diagnosis of AIS and treated with tPA. The setting was at a 552-bed, community hospital located in Southern California. The case hospital sees over 300 stroke patients annually and has an average tPA treatment rate of 19%. All staff working as members of the Stroke Response Team (SRT) (i.e. ED physicians and charge nurses, neurologists who take stroke call, rapid response nurses, radiology and laboratory technicians, pharmacists) recognized the importance to improve DTN times and viewed the goals as part of their role on the SRT. The SRT routinely attend a scheduled one-hour meeting each month to review stroke cases and data on stroke core measure metrics as part of their continuous performance improvement. The Project Leader used this scheduled meeting time to provide the one-hour education and implementation planning of the project. The Project Leader was responsible for reviewing the current literature, designing and leading the project, teaching the education sessions, and analyzing the data.

Sample, Data Collection, & Analysis

The Institutional Review Boards at UCLA and the case hospital's institution reviewed and approved the QI project. De-identified data from the analytics department of the case hospital was provided to the Project Leader for Group 1 and Group 2 so that the information could be analyzed and compared. The Project Leader retrieved the de-identified data and entered the information from Group 1 and Group 2 into a spreadsheet titled, Stroke Performance Worksheet, for that specific three-month time period (see Table 8.1). Data elements included: 1) date and time of patient arrival to the ED, 2) mode of arrival (EMS or walk in), 3) National Institute of Health Stroke Scale (NIHSS) on arrival and discharge, 4) time seen by the physician, 5) time seen by the SRT, 6) time to CT scan from arrival, 7) time to CT interpretation from arrival, and 8) DTN time from ED arrival. All analyses comparing Group 1 versus Group 2 data were completed using Microsoft Excel's Analysis ToolPak Version 16. The differences in the means of each of the above were compared using *t* tests. The level of significance was set at $P < 0.05$.

Educational Sessions

The Project Leader provided a one-hour educational session to key members of the ED staff and SRT with the following teaching objectives: 1) compare and contrast the national standards to current practice and its potential effect on patient outcomes, 2) discuss the relevance of changing current SRT performance as it applies to improving quality and cost, 3) identify Target: Stroke 12 Best Practices' to improve DTN times, 4) differentiate Target: Stroke recommended time intervals to achieve DTN times, 5) describe the stroke acronym, BE-FAST (see Appendix G). Prior to the educational session, the Project Leader modified the case hospital's current acute stroke documentation form to include specific Target: Stroke time targets and deferring of unnecessary tests and procedures until direct CT scan and tPA administration was completed (see Appendix D).

Each educational session was taught using a PowerPoint presentation and included the AHA's Target: Stroke Phase III Best Practices. The goal was to specifically target the best practice of direct transport to CT scan, and to emphasize evidence regarding reduced DTN times, improved patient outcomes, and compliance with national guidelines. After the one-hour educational session, the participants were asked to complete a 12-question evaluation form on the educational session using a five-point rating scale regarding their response to the educational intervention and evaluation of project (see Appendix F).

Demographic Questionnaire and Pre and Post Test

A one-page demographic questionnaire and a pre-test was given to the ED and SRT participants prior to the start of the educational session. The data established the characteristics of the participants and receptivity of educational content. The demographic questionnaire (see Appendix H) and the pre-test (see Appendix I) included professional and departmental information (doctor, nurse, advanced practice nurse, technician], years of clinical experience, education level, certification status, length of time on the SRT, knowledge of Target: Stroke Best Practices, recommended time targets and stroke acronym BE-FAST. At the conclusion of the educational session, the class participants were given a post-test, which included the same questions from the pre-test, to assess and compare their scores before and after the educational session. There was no identifiable staff information documented on the surveys or pre and post-tests. All data collected from survey and pre and post-tests were reported in aggregate format.

Instrument National Institute of Health Stroke Scale (NIHSS)

The NIHSS is a global, systemic assessment tool that provides healthcare providers to objectively quantify the impairment caused by a stroke. The scale is also widely used as a clinical assessment tool to evaluate acuity of stroke patients, determine appropriate treatment, and predict patient outcome (National Institute of Neurological Disorders and Stroke, 2019). For each item, a score of 0 typically indicates normal function in that specific ability, while a higher score is indicative of some level of impairment. The individual scores from each item are summed in order to calculate a patient's total NIHSS score. The maximum possible score is 42, with the minimum score a 0. The NIHSS for Group 1 and Group 2 were entered into the Stroke Performance Worksheet for comparison.

Project Intervention

The goal of this QI project was to increase staff’s awareness and knowledge of Target: Stroke and processes for the direct transport of stroke patients to the CT scan to improve DTN times. In order to implement the EBP change, the current stroke protocol was modified to reflect AHA’s Target: Stroke to achieve DTN within 30 minutes. This included each action step and the time interval needed to meet the recommended time target. In addition, the Acute Stroke Documentation Form was revised to defer unnecessary procedures and tests in the ED until the CT scan was performed and administration of tPA was given.

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Chapter 5

Results

Stroke Educational Session: Pre and Post-test Scores

There was a total of 14 AIS patients treated with tPA in Group 1 and total of 16 AIS patients treated with tPA in Group 2. Group 1's mean door-to-CT times and mean DTN times were compared to Group 2's mean door-to-CT times and mean DTN times. The data collection date for Group 2 began on January 20, 2020, after the educational sessions were completed and the Acute Code Stroke Documentation Form was revised (see Appendix D). There were 3 education sessions provided to the ED staff and SRT during the month of January 2020 by the Project Leader. A total of eighty participants from the ED and SRT participated in the stroke educational sessions that took place in January 2020. A paired t-test analysis of the 80 pre and post test scores revealed a significant difference ($P < 0.001$)(see Table 1.1). On average, the post-test scores were approximately 19 points higher than the pre-test scores.

Table 1.1 Pre and Post Paired Sample Statistics (n=80)

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	75.38	80	13.78	1.54
	Post-Test	94.07	80	7.95	.89

Pre and Post Test Paired Samples Test (n=80)

		Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	T	Df	Sig. (2-tailed)
Pair 1	Pre-Test/Post Test	18.69	12.17	1.36	21.4	15.99	13.74	79	**0.001**

Class Participant Demographics

The class participants' demographic data are presented in Table 2.1. Over half of the participants (62.5%) are nurses from the ED. The SRT is represented by an interdisciplinary team comprised of stroke neurologists, critical care nurses and ancillary staff. The case hospital coordinates the care of stroke patients through an interdisciplinary team approach. The ED physicians and nurses work in collaboration with the SRT to assess, diagnose, and provide treatment for the stroke patients who enter the ED via EMS or by walk in. Over half of the class participants had a bachelor's degree and average years of work experience between 6 to 10 years. The class participants represented key clinicians and stakeholders within the case hospital to ensure that the project's goals were in alignment with the vision and values of the case hospital.

Table 2.1 Demographic Characteristics of Class Participants (n=80)

Job Title	**N, %**
Physician	10 (12.5%)
Advanced Practice Nurse	4 (5.00%)
Registered Nurse	50 (62.5%)
Physician Assistant	1 (1.25%)
Pharmacist	3 (3.75%)
Technician	5 (6.25%)
Allied Health	3 (3.75%)
Administration	4 (5.00%)
Educational Level	
High school diploma	0 (0.00%)
Some college	0 (0.00%)
Trade school	5 (6.25%)
Associates	1 (1.25%)
Bachelor Degree	44 (55.00%)
Master Degree	17 (21.25%)
Doctoral Degree	13 (16.25%)
Years of Experience	
<1	0 (0.00%)
1- 5	25 (31.25%)
5-10	30 (37.50%)
>10	25 (31.25%)
Area of Practice	
ED	49 (61.25%)
Radiology	7 (8.75%
Neurology	4 (5.00%)
Neurosurgery	1 (1.25%)
Laboratory	2 (2.50%)
Pharmacy	3 (3.75%)
Administration	4 (5.00%)
Quality	2 (2.50%)
Critical care	7 (8.75%)
Admitting	1 (1.25%)

Educational Session Evaluation

Upon completion of the educational session, the 80 participants completed a ten-question evaluation of the educational session. (see Table 3.1). Greater than 50% of the participants felt that they would be able to apply what they learned; in addition they believed the information was pertinent and useful to their work setting. In terms of areas of concern and opportunities, approximately half of the participants felt that there was not enough time for questions and answers during the session. Ten participants ranked "disagree/strongly disagree" the class time was not as focused due to disagreements and discussions over procedures and treatments that could be delayed until after the CT. The Project Leader mitigated disagreements by refocusing on evidenced-based guidelines and was able to gain consensus among the physicians. Overall, more than half of the participants felt that the overall rating of the class met their expectations.

Table 3.1 Educational Session Evaluation (n=80)

Question	Total Participants (n=80) M/SD or %	% Answering Strongly Agree/Agree/ Excellent
The class session met my expectations	1.21 (0.50)	83%
I will be able to apply the knowledge learned	1.18 (0.44)	85%
The class objectives were clear and relevant to my role	1.40 (0.67)	70%
The content was organized and easy to follow	1.34 (0.48)	66%
The information presented were pertinent and useful	1.14 (0.35)	86%
The project leader was knowledgeable	1.00 (0.0)	100%
The quality of instruction was good	1.05 (0.22)	95%
The project leader met the class objectives	1.31 (0.56)	85%
Adequate time for questions and discussion	1.75 (0.70)	48%
*Overall class rating	1.54 (0.59)	74%
Average across 10 items	1.23 (0.83)	51%

M = mean; SD = standard deviation
% = answering agree/strongly agree
1 = agree/strongly agree/* excellent
2 = neutral/* good/average
3 = disagree/strongly disagree/*poor

Demographic and Clinical Characteristics of AIS Patients

Demographic and clinical characteristics data for AIS patients are presented in Table 4.1. The mean age of patients in Group 1 was similar to Group 2 and over half of the patients were females in both groups. Similar to other research studies, the patient population in this sample were predominantly Caucasian, with multiple stroke symptoms upon arrival, and had an average length stay of 3 to 4 days (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Kamal et al., 2017, Tan et al., 2018, Threlkeld et al., 2017). Over half of the patients in Group 1 and 2 were discharged home and diagnosed with ischemic stroke upon CT confirmation. In Group 2, the in-hospital death and in-patient transfer to rehab decreased by over half as compared to Group 1.

Table 4.1 Demographic and Clinical Characteristics of All Stroke Patient Sample (Total n=206)

Variable	Group 1 (n=122)	Group 2 (n=84)
Age (years)		
Mean ± SD	74 ± 13.57	72 ± 15.99
Gender (n, %)		
Female	69, 57%	40, 48%
Male	53, 43%	44, 52%
Race (n, %)		
Asian	8, 6%	4, 5%
Black	0, 0%	3, 4%
Hispanic	2, 2%	7, 8%
Other	13, 11%	5, 6%
White	99, 81%	65, 77%
Patient arrival (n, %)		
EMS	83, 68%	49, 58%
Walk In	39, 32%	35, 42%
Type of Stroke (n, %)		
Hemorrhagic	34, 28%	10, 12%
Ischemic	88, 72%	74, 88%
Medical History (n, %)		
Atrial fibrillation	2, 2%	2, 2%
Diabetes mellitus	4, 3%	2, 2%
Dysplidemia	3, 2%	4, 5%
Hypertension	12, 10%	11, 13%
None	10, 8%	10, 12%
Previous Stroke	1, 1%	4, 5%
Smoking	1, 1%	0, 0%
> 2 co-morbidities	89, 73%	51, 61%
Symptoms on arrival (n, %)		
Dizziness	1, 1%	4, 5%
Facial droop	2, 1%	0, 0%
Headache	7, 6%	6, 7%
Limb weakness	7, 6%	20, 24%
Speech difficulty	6, 5%	10, 12%
Multi-symptoms	95, 78%	44, 52%
Visual impairment	4, 3%	0, 0%
Length of stay (n, %)		
1-2 days	42, 34%	42, 50%
3-4 days	61, 50%	21, 25%
>5 days	19, 16%	21, 25%
Discharge status (n, %)		
Hospice	3, 3%	5, 6%
In-hospital death	20, 16%	6, 7%
In-patient rehab	23, 19%	8, 9%
Self-care home	50, 41%	45, 54%
Skilled nurse facility	16, 13%	17, 20%
Outside hospital	10, 8%	3, 4%
Treated with tPA (n, %)	14, 11%	16, 19%

Outcomes in AIS Patients treated with tPA
Group 1 (n=14) Group 2 (n=16)

The mean door-to-CT scan decreased from 35 minutes in Group 1 to 17 minutes in Group 2 ($P < .001$). The mean DTN time also decreased from 52 minutes in Group 1 to 32 minutes in Group 2 ($P < .001$). Over half of the patients in Group 2 received tPA in under 30 minutes as compared to Group 1. On average, the mean door-to-CT scan times improved by 18 minutes and the mean DTN times improved by 20 minutes in Group 2 as compared to Group 1. Interventions with the greatest impact on decreasing DTN time were deferring laboratory and diagnostic tests (CXR and EKG) and administering tPA while the patient remained in the CT scan.

The results of the door-to-MD time in both Group 1 and Group 2 remained similar. This may be the result of the EMS pre-notification of the incoming "Code Stroke" patient arrival to the ED so that the ED physician can be ready to receive the patient at the entrance. EMS hospital pre-notification has been associated with improved evaluation, timelier stroke treatment, and an increase of eligible patients treated with tPA **(**Kamal et al., 2017, Bhatt et al., 2019). There was a patient in Group 2 who had a substantially longer delay related to presenting to the ED as a walk-in admission. The patient was 19 years of age who presented with chief complaint of headache and neck pain after seeing a chiropractor. The triage nurse assessed that the patient's NIHSS score was low risk and did not feel that a "Code Stroke" needed to be initiated. The patient was transferred into the ED bay until the code stroke was called by ED physician. The ED physician's NIHSS score of the patient was significantly higher than the triage nurse's original NIHSS score. After the event occurred, the stroke APN met with the ED triage RNs and provided re-education on identifying stroke symptoms. The NIHSS on arrival and discharge in Group 2 was significantly lower in Group 1.

Table 5.1 Outcomes in Group 1 (n=14) and Group 2 (n=16) groups treated with tPA

Outcome	**Group 1 (n=14)**	**Group 2 (n=16)**	**Significance *(P* value)**
Door to MD, mean (Interquartile range [IQR])	4.71(1-7)	4.75 (0-6)	0. 987
Door to Stroke Team, mean (IQR)	5.14 (2-8)	3.18 (1-7)	0.271
Door to CT Scan, mean (IQR)	35.28 (32-38)	17.38 (11-21)	**< .001**
Door to CT Read, mean (IQR)	47.71 (45-52)	23.75 (17-28)	**< .001**
Door to tPA, mean (IQR)	52.57 (48-60)	32.25 (27-35)	**< .001**
NIHSS score on arrival mean (IQR)	10.29 (4-16)	6.69 (0-2)	0.182
NIHSS score on discharge, mean, (IQR)	4.92 (1-8)	2.94 (0-4)	0.291

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Chapter 6

Discussion

The DTN time is increasingly being used as a performance measure to assess and monitor the quality of care in stroke centers around the nation. The therapeutic window and efficacy of tPA administration following AIS is short and vital. Increased studies have shown a reduction in DTN times with several institution's implementing Target: Stroke Best Practices (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Fonarow et al., 2014, Kamal et al., 2017, Tan et al., 2018, Threlkeld et al., 2017). In this QI project, the door-to-CT times and DTN times were significantly reduced by providing education on Target: Stroke Best Practices and creating a higher and sustained awareness on the importance of adding direct to CT transport onto the acute stroke documentation form. The educational sessions also empowered the ED staff and SRT to implement the EBP and national guidelines at the case hospital, which resulted in DTN times under 30 minutes in at least 62% of patients in Group 2.

Several studies improved DTN times significantly ($P < 0.001$) by incorporating early EMS notification of stroke patient arrival, direct transport to CT scan, and administering tPA in the CT scan area (Caputo et al., 2017, Kamal et al., 2017, Tan et al., 2018). Several studies have shown that early initiation of tPA administration in eligible AIS patients improves outcomes. However, data from the AHA and Get with the Guidelines participating hospitals indicate that the median DTN time was 75 minutes. Additionally, less than 30% of all AIS patients treated with tPA achieved DTN times in less than or equal to one hour (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Fonarow et al., 2014, Kamal et al., 2017, Tan et al., 2018, Threlkeld et al., 2017).

Relationship between Educational Sessions and DTN times

The educational sessions used in this QI project potentially increased knowledge, team awareness, fostered collaboration and obtained buy-in to successfully implement EBP and national guidelines to improve DTN times. Similar strategies were used by other institutions to improve their stroke performance metrics and team effectiveness. Several studies developed a DTN task force to implement a direct-to-CT transport protocol through formal, didactic training and education sessions with physicians and nurses from the ED, radiology, neurology and pharmacy departments. The DTN task force solicited input and buy in from participants regarding departmental workflow as compared to national stroke guidelines. The researchers attributed the successful implementation of the stroke protocol and reduced DTN times to a team-based approach, prompt data feedback to stakeholders, buy in, and collaboration in the development and evaluation process (Threlkeld et al., 2017, Caputo et al., 2017, Bhatt et al., 2019). Using the successful strategies and incorporating them into the design of this QI project may have empowered frontline staff and providers to work collaboratively and translate the existing national evidence into current SRT performance at their institution to improve quality, outcomes and cost-efficient patient care.

Outcomes in Group 1 and Group 2 treated with tPA

Direct Transfer to CT Scan

Ten of the 12 Target: Stroke Best Practices were already in place as part of the protocol at the case hospital. In this QI project, we added the two additional guidelines of direct transfer to CT scan and premixing and administration of tPA in the CT scan immediately after confirmation of AIS. Similar to other studies, the acute stroke process prior to the intervention was that patients suspected of having a stroke for which a “code stroke” notification was activated were first taken to an ED bed upon arrival from EMS or walk in. Once in the ED, patients received an initial neuro assessment by an ED nurse, followed by the ED physician. Additionally, vital signs were obtained, initial laboratory tests run, EKG and CXR performed, and an intravenous line was placed (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Kamal et al., 2017, Tan et al., 2018, Threlkeld et al., 2017).

After the intervention, patients in Group 2 were taken directly from the ambulance bay to the CT Scan. The ED team would evaluate the patient for any respiratory or hemodynamic instability upon arrival and transport the patient to the CT scan, during which the SRT performed a rapid neurological assessment. The laboratory and diagnostic procedures were postponed until after the patient received the CT scan and given tPA in the CT scan, if deemed eligible. With the successful implementation of this project, the case hospital experienced a significant reduction in mean DTN time to 32 minutes, in alignment with national standards and goals (AHA, 2019).

Premixing of tPA and Administration in the CT scan

Prior to the intervention, confirmed AIS patients were returned to an ED bed from CT scan where tPA was mixed and administered by the SRT nurse. This process was like other studies prior to the intervention of direct to CT transport. After the intervention, storage for mixing and administration of tPA were available in the CT scanner room for immediate infusion once the diagnosis of AIS was determined. Prior studies included door-to-CT times and DTN times as a primary or secondary outcome measure (Bershad et al, 2015, Bhatt et al., 2019).

The data demonstrated that 62.5% of patients in Group 2 had DTN times in under 30 minutes. Previous studies have demonstrated the effect of implementing Target: Strokes best practices on decreased door-to-CT and DTN times. These best practices included the introduction of EMS pre-notification, stroke standard protocols, stroke team notification, timer or clock attached to patient chart or bed, direct transfer to CT scan, rapid interpretation of CT scan and laboratory testing, pre-mix of tPA, administration of tPA in CT scan, team-based approach and prompt data feedback (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Fonarow et al., 2014, Kamal et al., 2017, Tan et al., 2018, Threlkeld et al., 2017).

The remaining percentage (37.5%) of patients in Group 2 had DTN times ranging between 32 to 61 minutes, which were above national stroke guidelines (AHA, 2019). The variance for these DTN time delays were the result of the following: 1) two patients required more time to discuss tPA risk and benefits with family members, 2) two patients had uncontrolled hypertension (systolic blood pressure >185 mmHg) which precludes tPA administration, 3) one patient had a low NIHSS and symptoms were resolving which indicated that a CT scan was not a priority stat order, and 4) one patient was not appropriately diagnosed with stroke symptoms in the ED triage by the RN.

Consistent with results from other studies, the QI project implemented nine or more of the 12 Target: Stroke Best Practices which resulted in a significant reduction in DTN times (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Fonarow et al., 2014, Kamal et al., 2017, Tan et al., 2018, Threlkeld et al., 2017). In addition, the studies reported a significant ($P \leq 0.05$) improvement in the outcome of DTN times with a reduction of median door-to-needle times between 26 to 37 minutes.

The results of this project, compare favorably with those reported in previous analyses of large international stroke registries. In these stroke registries, the percentage of patients treated with DTN times less than 60 minutes ranged between 27% and 38%, compared with 62% in this project (Fonarow et al., 2011, Mikulik et al., 2012). Adding direct transport to CT and deferring laboratory and diagnostic procedures to the stroke protocol required the ED and SRT staff to work collaboratively in the change process that had been in place for several years. This required stakeholders, department leaders and the Project Lead to inspire and empower the team to be part of the decision making and evaluation processes.

Furthermore, the team was provided education on the new Target: Stroke Best Practices and its impact on clinical outcomes. The strategies needed to sustain the improved DTN times include: 1) to continue to post results of the stroke metrics in the ED and in the CT scanner room to help keep the SRT on track; 2) to provide positive feedback via e-mail to the entire team to increase the visibility and accountability of the team's performance; 3) to educate team members on an ongoing basis about new processes in annual competencies; 4) to on-board new staff; and, 5) to conduct in-service training sessions for the ED and SRT.

Limitations

This QI project has several limitations. First, the project was retrospective and number of AIS patients treated with tPA in Group 1 (n=14) and Group 2 (n=16) group were relatively small. The goal was to have at least a sample of 30 patients in Group 2. However, even with the small number of patients, the results revealed a significant decrease in door-to-CT scan and DTN times. Second, the national stroke guideline initiative does not have a concurrent control group of hospitals to compare with case hospital. This evidence based project was designed to revise and update a single community hospital's existing stroke protocols to national guidelines for the rapid identification and administration of a therapeutic agent for AIS patients. It is difficult to assess the effect of a single intervention in the reductions of door-to-CT times and DTN times. Some of the extraneous factors that could have potentially reduced the door-to-CT times and DTN times may have been physician and staff variability, compliance with following the protocol, day or time of the week, and resource availability (ED census and number of patients waiting for CT scan). Third, the project was conducted in a single site, Get with the Guidelines participating, community hospital setting with the organizational support and prioritization of this particular aspect of patient care and focused approach for a large population of stroke patients. Therefore, it cannot be presumed that every institution will be able to apply the same approach of the national guidelines given the variability in institutional policies, infrastructure, organizational structure and culture. An expansion of this study is warranted to assess the outcome of stroke protocols that include functional outcomes at 30- and 90-days post discharge from the hospital (Bershad et al., 2015, Bhatt et al., 2019, Caputo et al., 2017, Threlkeld et al., 2017). This would help determine long-term effects of the intervention on important outcomes such as functional status and ability to return to the workforce. Future studies should also include the effect of education and collaboration of interdisciplinary teams to improve stroke outcomes.

Implications for Nursing Practice and Research

For over two decades, it has been recognized that specialized stroke care can contribute to reducing disability, decreasing length of stay, decreasing mortality and improving clinical outcomes. Highly specialized nursing involvement is vital in achieving optimum patient outcomes, quality metrics, and cost-effective care. The care and delivery of stroke care must continue to be comprehensive, interactive, and holistic for both the acute stroke phase and rehabilitation phase (Theofanidis & Gibbon, 2016).

Nurses who work with the stroke population should be skilled in neuro assessments and be aware of the most current national stroke guidelines. In addition, hospital protocols should reflect evidence-based guidelines to direct nursing practice improve clinical outcomes. In addition, organizational support of the educational sessions proved to be a successful strategy in soliciting buy in from key stakeholders to facilitate the direct transport of AIS patients to the CT scan upon arrival and improve DTN times.

Conclusion

The goal of this QI project was to determine if education and increased awareness of the Target: Stroke Best Practices would influence direct transport to CT scan, as compared to current practice, and improve DTN times within a three-month period. The results of the project revealed that the educational sessions and implementation of direct transport to CT scan on the acute stroke documentation form significantly improved door-to-CT times and DTN times at the case hospital. The complexity of the stroke patient population requires that health care organizations deliver evidence-based care within the recommended time frames that maximize patient outcomes. This QI project describes the clinical problem of delays to DTN times and the evidence-based interventions and educational strategies on how to improve these outcomes. Although the QI project incorporated educational sessions and Target: Stroke Best Practices of direct transport to CT scan, it remains a continuous learning process. As such, a periodical review of performance to ensure that the acute stroke protocol is adhered to efficiently is critical. The Project Leader played a critical role in achieving consensus and buy-in from key stakeholders to influence motivation to change current practice in alignment with national guidelines. The success of this QI project was attributed to the tenets of this project that showed that empowering staff, providing education and bringing EBP into the institution had a positive impact to patient safety, quality of care, and increased compliance with national performance standards. The next steps will be to disseminate the results of the project through presentations and publications and to promote EBP in order to improve the timeliness of DTN times for the stroke population.

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Appendix A

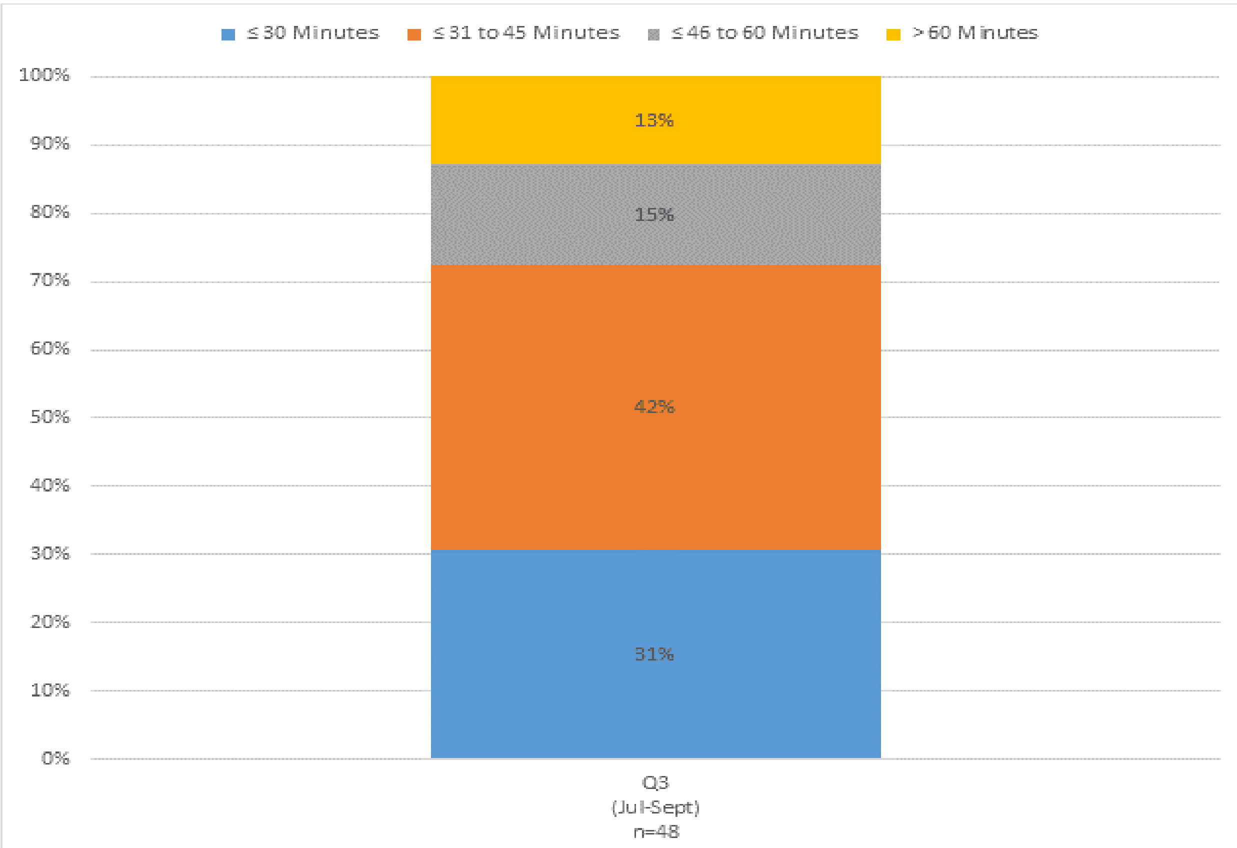
American Heart Association.
Target: Stroke℠

PHASE III
TARGET: STROKE℠
SUGGESTED TIME INTERVAL GOALS

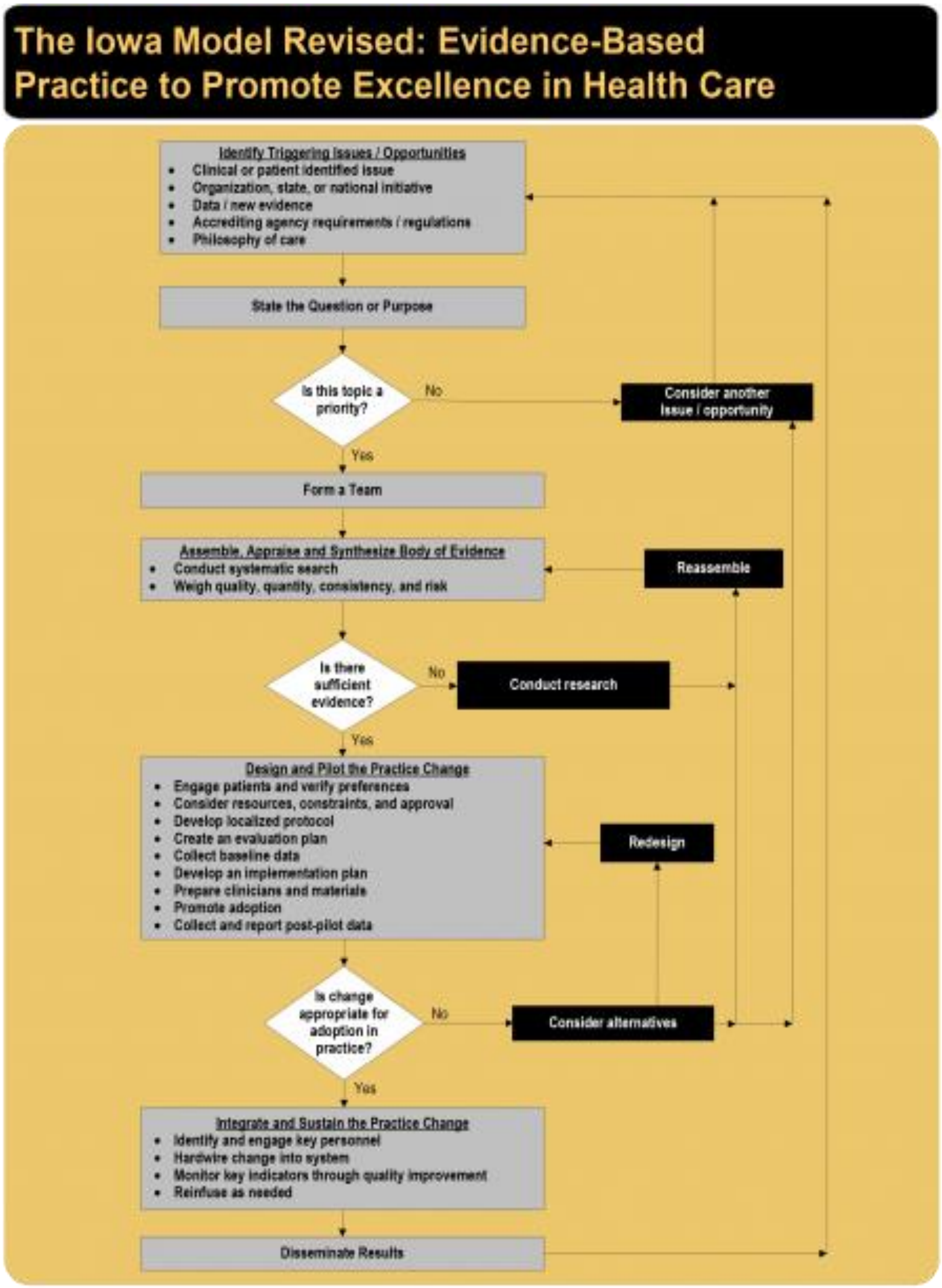
THE 30 MINUTES DTN GOAL TIME INTERVAL GOALS ARE:

ACTION	TIME
Door to physician	≤2.5 minutes
Door to stroke team	≤5 minutes
Door to CT/MRI initiation	≤15 minutes
Door to CT/MRI interpretation	≤25 minutes
Door to needle time	**≤30 minutes**

Appendix B: Case Hospital Door-to-Needle Times Percentages (15 patients out of 48 patients (31%) received tPA < 30 minutes (Case Hospital, 2019)



Appendix C: IOWA Model Revised



Appendix D: Acute Stroke Documentation

Mission Hospital ST JOSEPH

Mission Hospital Laguna Beach ST JOSEPH

ACUTE STROKE DOCUMENATION FORM

ED Times/In Patient Times

Stroke Alert: ____________

Patient Arrival: ____________

Neurologist /ED MD (who): ____________

Notified (Time): ____________

Stroke Response RN (who/time): ____________

CRITICAL PATIENT INFORMATION

When was patient last seen normal (usual state of health)?

Date________Time______Wakeup Stroke: Y N

Witness ____________

Phone number of Witness ____________

Allergies: ____________

Phase I: 0-10 minutes after Arrival in ED

□ Transfer to stroke gurney

□ Patient seen by physician and stroke response nurse

□ ED MD NIHSS Stroke & Phys Assess completed

Full NIHSS Score__________R.A.C.E.__________

□ Check Blood Glucose: BG: ____

□ IV access

□ Call CT dept to notify on route

Record Actual Times	Time Documentation	Time Goals from Arrival Time
	Door to ED MD exam	**< 2.5 minutes**
	Door to Stroke Response	**< 5 minutes**
	Door to CT Initiation	**< 15 minutes**
	Door to CT Interpretation	**< 25 minutes**
	Door to Needle (tPA_	**< 30 minutes**

If CT Scan positive for Hemorrhage →

Hemorrhage Type: □ ICH □ SAH

□ **Neurosurgeon Notification Time________**

□**VS/Neuro Checks** (May use GCS after ICH confirmed) q 30 minutes x 2, then hourly

□ **Maintain SBP < 140 mm Hg**

□ Reassess pupils hourly (Consider Pupilometer)

ICH:

□ Neuro Physician documents ICH Score

□ SICU Charge Contacted on Patient Admit

□ Physician completes ICH order set

SAH:

□ Neuro Physician documents Hunt/Hess Score

□ IR/OR team notified of transfer (if applicable)

□ Physician completes Pre Clip/Coil SAH order set

Notes: ____________

ISCHEMIC STROKE ONLY

Phase II: 25-45 minutes after CT interpretation/tPA

Secondary IV access/blood for labs,

Plts:________PT/ INR:_____Cr_____

□ Initial VS/Neuro Checks then q 30 minutes x 2

□**Reassess BP (< 185/110 mm Hg) prior to tPA**

□ Neurologist completes paper IV tPA order sheet

□ **Reassess VS/NISHH** q 15 min x 8, q 30 x 6, q 1h

□ Neurologist/Hospitalist completes IV tPA order set

□No tPA -Neurologist/Hospitalist completes Ischemic Stroke order set

□ CXR and EKG

Record Actual Times	Time Documentation	Time Goals from Arrival Time
	Door to IV tPA Bolus (DTN)	30 minutes
	Code Stroke Tier 1 Activation	30 minutes
	Door to Groin Puncture	90 minutes

Handoff:

ED RN/RRT RN to Receiving unit

□ Neuro Exam

□ Current BP & Medications administered

Patient Sticker/ID Here

RN Signature______________________Time______

Appendix E: Comprehensive Stroke Core Measures

STROKE FACT SHEET

American Heart Association | American Stroke Association — life is why | GET WITH THE GUIDELINES. STROKE

BACKGROUND

In July 2014, The Joint Commission (TJC®) approved a set of standardized performance measures for Comprehensive Stroke Certification mandatory for all Comprehensive Stroke Centers (CSC). These comprehensive stroke (CSTK) measures were developed for the management of both ischemic and hemorrhagic stroke patients in hospitals equipped with the clinical expertise, infrastructure, and specialized neurointerventional and imaging services needed to provide the next level of stroke care. In addition to these new comprehensive stroke performance measures, CSCs must continue to meet the performance measure requirements for Primary Stroke Centers.

To further support hospital processes and the delivery of care that are strongly supported by science, Get With the Guidelines Stroke Program supports the collection of the CSTK measures. Additionally, the Get With the Guidelines expert leaders have developed additional Get With the Guidelines Comprehensive measures. This fact sheet provides an overview of both the standardized Comprehensive Stroke measures and the additional GWTG Comprehensive measures available for reporting within the Get With the Guidelines-Stroke Patient Management Tool.

TJC® STROKE MEASURES

Certification is available only to Joint Commission-accredited acute care hospitals that meet all the general eligibility requirements for Disease-Specific Care and Primary Stroke Center (PSC) certification. Certified Comprehensive Stroke Centers are required to meet the performance measurement requirements for Primary Stroke Centers, including the collection of data for the eight stroke core measures and submission of monthly data points every quarter through the Certification Measure Information Process. Below are the Stroke Core (STK) measures.

- **STK-1:** Venous Thromboembolism (VTE Prophylaxis)
- **STK-10:** Assessed for Rehabilitation
- **STK-2:** Discharged on Antithrombotic Therapy
- **STK-3:** Anticoagulation Therapy for Atrial Fibrillation/Flutter
- **STK-4:** Thrombolytic Therapy
- **STK-5:** Antithrombotic Therapy by End of Hospital Day Two
- **STK-6:** Discharged on Statin Medication
- **STK-8:** Stroke Education

TJC® COMPREHENSIVE STROKE MEASURES

The Comprehensive Stroke measure set consists of ten standardized measures. Data for these ten CSTK measures is collected in addition to the eight stroke core measures required for primary stroke center certification, elevating the performance measurement requirement for comprehensive stroke certification to a total of 18 measures. Below are the ten CSTK measures required for discharges on and after January 1, 2018.

- **CSTK-01:** National Institutes of Health Stroke Scale (NIHSS Score Performed for Ischemic Stroke Patients)
- **CSTK-03:** Severity Measurement Performed for SAH and ICH Patients (Overall Rate)
- **CSTK-04:** Procoagulant Reversal Agent Initiation for Intracerebral Hemorrhage (ICH)
- **CSTK-05:** Hemorrhagic Transformation (Overall Rate)
- **CSTK-06:** Nimodipine Treatment Administered

Appendix F: Class Evaluation Form

Please indicate your impressions of the items listed below.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The class session met my expectations.	❍	❍	❍	❍	❍
2. I will be able to apply the knowledge learned.	❍	❍	❍	❍	❍
3. The class objectives were clear and relevant to my role.	❍	❍	❍	❍	❍
4. The content was organized and easy to follow.	❍	❍	❍	❍	❍
5. The information presented were pertinent and useful.	❍	❍	❍	❍	❍
6. The Project Leader was knowledgeable.	❍	❍	❍	❍	❍
7. The quality of instruction was good.	❍	❍	❍	❍	❍
8. The Project Leader met the class objectives.	❍	❍	❍	❍	❍
9. Class participation and interaction were encouraged.	❍	❍	❍	❍	❍
10. Adequate time was provided for questions and discussion.	❍	❍	❍	❍	❍

11. How do you rate the training overall?

Excellent	Good	Average	Poor	Very poor
❍	❍	❍	❍	❍

12. What aspects of the training could be improved?

Appendix G: Educational Session Teaching Objectives

Appendix H: Demographic Questionnaire

Target: Stroke Questionnaire

I am requesting for your assistance in participating in following survey and pre and post-test for the purposes of my research study. The questionnaire is anonymous and will not be linked to your name/role.

1. What is your job title? Please circle or write in)

    a. MD (Medical Doctor)
    b. DO (Doctor of Osteopathy)
    c. APRN (Advanced Practice Nurse- CNS, NP)
    d. Nurse (specify RN, LPN, BSN) _________________________
    e. PA (Physician’s Assistant)
    f. Pharmacist
    g. Technician (List Specialty)_____________________ _
    h. Allied Health (List Specialty)___________________ _
    i. Administrator
    j. Other: _________________________

2. What is the highest degree or level of school you have completed? If currently enrolled, highest degree received.

    a. High school graduate, diploma or the equivalent (for example: GED
    b. Some college credit, no degree
    c. Trade/technical/vocational training
    d. Associate degree
    e. Bachelor’s degree
    f. Doctorate degree

3. How many years of experience do you have in managing acute ischemic stroke patients?
    a. 0-1 year
    b. 1-5 years
    c. 5-10 years
    d. 10 + years

4. In what area do you primarily practice? You may select more than one.
    a. Emergency Room
    b. Interventional Radiology
    c. Neurosurgery

Appendix I: Pre and Post Test

1. Are you familiar with the American Heart Association: Target: Stroke 12 Best Strategies for reducing door-to-needle times for acute ischemic stroke patients

    a. Yes
    b. No

2. Of the following practices, which practice is **NOT** part of Target: Strokes 12 Best Practices for reducing door-to-needle times?

    a. Obtain start time of symptom onset
    b. Transfer directly to CT Scan
    c. Placement of secondary IV

3. What is the new target time goal for tPA administration for AIS patient from the time they arrive to the ED?

    a. 45 minutes
    b. 60 minutes
    c. 30 minutes

4. What is the time target to get the stroke patients to the CT scan?

    a. Within 15 minutes
    b. Within 60 minutes
    c. Within 30 minutes
    d.

5. What is the time target to have the CT scan results interpreted?

    a. Within 30 minutes
    b. Within 60 minutes
    c. Within 25 minutes

6. Do you know what the stroke acronym BE-FAST for symptoms are?
   Please list below:

   B-______________
   E-______________
   F-______________
   A-______________
   S-_______________
   T-_______________

Table 6.1 Target: Stroke 10 Best Practices (AHA, 2010)

10 Best Practice Strategies
1. EMS Pre-Notification
2. Stroke Tools (Sample AHA stroke order sets and algorithms)
3. Rapid Triage Protocol and Stroke Team (In-house notification system i.e. text, call, overhead page)
4. Single Call Activation System
5. Rapid Acquisition and Interpretation of Brain Imaging
6. Rapid Laboratory Testing (Including Point of Care (POC) Testing if indicated
7. Mix tPA Ahead of Time
8. Rapid Access and Administration of tPA
9. Team-Based Approach
10. Prompt Data Feedback

Table 7.1 Target: Stroke 12 Best Practices (AHA, 2019) and Case Hospital Practices

Two New Additions: Highlighted in Yellow

12 Best Practice Strategies & Case Hospital Practices	Yes	No
1. EMS Pre-Notification	X	
2. Stroke Tools (Sample AHA stroke order sets and algorithms)	X	
3. Rapid Triage Protocol and Stroke Team (In-house notification system i.e. text, call, overhead page)	X	
4. Single Call Activation System	X	
5. Time or clock attached to chart, clip board or patient bed	X	
6. Transfer Directly to CT Scanner		X
7. Rapid Acquisition and Interpretation of Brain Imaging	X	
8. Rapid Laboratory Testing (Including Point of Care (POC) Testing if indicated	X	
9. Mix tPA Ahead of Time		X
10. Rapid Access and Administration of tPA	X	
11. Team-Based Approach	X	
12. Prompt Data Feedback	X	

Table 8.1 Target: Stroke Performance Worksheet

Subject #	Time of Arrival (Door)	NIHSS on Arrival	NIHSS on D/C	Mode of Arrival (EMS /Walk in)	Physician Actual Arrival Time	Door to Physician Target < 2.5 min Yes- 1 No- 2	Stroke Team Actual Arrival Time	Door to Stroke Team Target < 5 min Yes- 1 No- 2	CT initiation Actual Time	Door to CT initiation Target < 15 min Yes- 1 No- 2	CT Interpretation Actual Time	Door to CT Interpretation Target < 25 min Yes- 1 No- 2	Door to needle (tPA) Actual Time	Door to needle (tPA) Target < 30 min Yes- 1 No- 2

Table of Evidence

AUTHOR, YEAR	PURPOSE	SAMPLE & SETTING	METHODS (DESIGN INTERVENTIONS OUTCOME MEASURES)	RESULTS	DISCUSSION, INTERPRETATION, LIMITATION OF FINDINGS
Bershad, E. M., Rao, C. P., Vuong, K. D., Mazabob, J., Brown, G., Styron, S. L.,…Suarex , J. I. (2015). Multidiscipl	**Purpose**: To evaluate the effects of a structured multidisciplinary protocol for head CT turnaround times (TT) in acute stroke patients.	**Sample**: n=1808 acute stroke patients evaluated in the ED for tPA. **Setting**: ED as the Baylor Saint Luke's Medical Center, Houston, TX, a comprehensive stroke center	**Design**: An observational study using retrospective, cross-sectional analysis of the hospital's prospectively collectively collected head CT times entered into the GWTG database from January 2008 to July 2012. **Procedure**: Dedicated stroke coordinators who received formal training prospectively	**Results:** Shapiro-Wilk test (*p* $\leq$ 0.05) and visual histogram for CT TT times revealed data were non-normally distributed with skewness of	**Discussion**: Targeted protocol for CT scanning linked to reduced CT TT times. DTCT time read is essential step in determining tPA eligibility. Essential for most stroke pts to go to

inary protocol for rapid head computed tomography turnaround time in acute stroke patients. *Journal of Stroke and Cererbrovascular Diseases*, *24*(6), 1256-1261. doi.org/10.1016/j.jstroke			entered data for the GWTG database. Quality of data verified by random audit. **Intervention:** Implemented a multidisciplinary protocol that addressed three major areas: 1) identification and triage (ED) 2) radiology to facilitate early CT 3) multidiscipline for education and monthly feedback. **Outcome Measures:** Door-to-CT start time and CT turnaround time. **Analysis:** Data analysis of	6.491 (standard error = 0.058) and kurtosis of 98.06 (standard error = 0.115) for all patients. Therefore, non-parametric testing was performed. Median CT TT times for first 6 months was 27 (IQR, 27) and decreased to 18 (IQR< 12) post implementation ($p < .0001$ for	CT scan to avoid unnecessary delays. **Limitations**: Single site study, thus results not generalizable. Retrospective study and initial data was collected by internal staff. Lack of randomization limits ability to establish causation. Future studies are needed to validate the benefit of stroke protocol at other sites.

cerebrovasdis.2015.01.029.			CT time intervals by six-month periods (before and after protocol) was performed using Kruskal-Wallis test. Additional comparison of six-month period was performed using Mann-Whitney *U* test. Bonferroni correction used for multiple analyses. Significance was defined a $p \leq 0.05$.	pairwise comparisons) Median CT TT times was 18 (IQR, 12) versus 20 (IQR, 14) minutes for stroke pts (n= 1123) versus non-stroke pts (n = 685; $p < .0001$) No significant differences in CT start to report time in stroke vs non-	

				stroke pts: 11 (IQR, 8) vs 12 (IQR, 8) minutes, *p* = .189.	
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Bhatt, N., Marulanda-Londono, E. T., Atchaneeyasakul, K.,	**Purpose:** To evaluate the effect of implementing four AHA/ASA Target: Stroke best practices to	**Sample**: n= 274 patients admitted to ED for AIS. 148 patients in the pre-implementation group and 126 in	**Design**: Observational study comparing pre-implementation group vs implementation group vs post-implementation group. Retrospective analysis on AIS pts treated with tPA with pre-	**Results:** Median door-to-needle improved from 59 (IQR, 52-80) to 29 (	**Discussion:** Implementation of 5 best practices significantly decreased door-to-needle times

Malik, A. M., Asdaghi, N., Akram, N.,…Romano, J. G. (2019). Target stroke: Best practice strategies cut door to thrombolysis time <30 minutes in a large urban academic comprehensi	improve door-to-needle times. Four strategies were implemented: EMS prenotification, direct transfer to CT scan, administer of tPA in CT scan, and team based approach.	post implementation group. **Setting**: the ED at Jackson Memorial Hospital, Florida, a 1550 bed acute care urban tertiary academic center.	implementation dates (Jan. 1, 2013 to Mar. 21, 2015) and post-implementation dates (Mar. 22, 2015 to Apr. 30, 2015). **Intervention:** Gap analysis on door-to-needle time delays resulted in implementation of 5 Target: Stroke Best Practices: 1) EMS notification, 2) direct transfer to CT, administer of tPA in CT,3) storing and administering tPA in CT, 4) team-based approach, 5)prompt data feedback to team).	IQR, 20-41) minutes ($p <$ .001). DTC time decreased from 17 (14-21) to 16 (12-19) minutes ($p =$ .16) CT- tPA improved from 43 (IQR, 31-59) to 13 (IQR, 6-23) minutes ($p <$.001). Rates of intracerebral hemorrhage	tPA post implementation group (9.7pts/month) was significantly higher than pre-implementation (5.5 pts/month) Implementation of process improvement intervention results in sustained door-to-needle times. Limitations: Retrospective, single study site results not

ve stroke center. *The Neurohospitalist, 9*(1), 22-25. doi:10.1177/194187441880I443.			**Outcome Measures:** Door-to-needle time and door-to-CT time and CT to tPA time. **Analysis:** *T* tests and Chi-Square were used to compare groups. Significance was defined as $p \leq .05$	(2.7% vs 3.2%, p = .82). Treatment of stroke mimics (9% vs 13%, p=.31) EMS pre-notification in post-implementation group (60% vs 2%, $p < .01$).	generalizable. Future studies need for 90- day stroke outcomes in pts treated with tPA.

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Caputo, L. M., Jensen, J., Whale, M., Kozlowski, M. J., Fanale, C. V., Wagner, J. C., Bar-Or, D. (2017). How a ct-direct protocol at	**Purpose:** To describe a direct to CT protocol to streamline process of AIS pts and compare door-to-needle times and intracranial hemorrhage rates before and after protocol implementation.	**Sample**: n= 295 adult patients admitted for AIS and treated with tPA. Pts who received tPA prior to admission excluded. **Setting**: Single site, high volume, urban Hospital with designation as a	**Design**: An observational study with prospective data collection comparing pre and post protocol implementation. Prospective data for AIS pts treated with tPA pre-intervention (Jan 1, 2010-Mar.31, 2014) and post-implementation (Apr. 1, 2014 to May 31, 2015) of the direct-CT protocol.	**Results**: 295 pts with AIS treated with tPA included in study (211 pts were treated, 84 pts were treated after post-implementation). Median door-	**Discussion:** Implementation of streamlined CT-direct protocol for AIS pts and eliminating unnecessary steps resulted in decreased door-to-needle times, without increasing intracerebral

an american comprehensive stroke center led to door-to-needle times less than 30 minutes. *The Neurohospitalist, 7*(2). 70-73. doi:10.1177/1941874416672783.		comprehensive stroke center.	**Intervention:** Developed and implemented a direct CT protocol to increase efficacy of the initial evaluation of AIS patients. Protocol included: 1(EMS in field notification of AIS patient, 2) patient brought to a "launchpad" and assessed by stroke team, 3) tPA pre-mixed for patient transferred to CT scan 4) CT interpreted, 5) IV time out conducted, 6) tPA administered in CT scan. **Outcome Measures:** The door-to-needle times	to-needle times significantly reduced by 10 (38 min to 28 min) post implementation ($p < .001$). Distribution of pts treated three time treatment windows had significant change. Increase in pts with door-to-needle times < 30 min and	hemorrhages rates. Protocol resulted in 10 min decrease in median door-to-needle times. **Limitations:** Retrospective, single study site, results limited and not generalizable. Future studies needed to examine effects of CT direct protocol on pts functional outcomes.

			examined as median times and time treatment windows and sICH rates were compared pre and post implementation. **Analysis**: Mann-Whitney *U* test used to analyze median door-to-needle times. Fishers exact $\chi 2$ analysis used do compare time and demographics. Demographics (age, race, gender) and stroke scale score also compared. Prospective data for AIS pts treated with tPA pre-	decease in pts with door-to-needle times 31 to 60 min ($p <$ .001). Demographics between 2 groups ($p > .05$) Mean SD was significantly higher (72,1[18.0] vs 76.5[13.8]; $p \leq$ .05).	

			intervention (Jan. 1, 2010-Mar. 31, 2014) and post-implementation (Apr. 1, 2014 to May 31, 2015) of the direct-CT protocol. Pts who received tPA prior to admission excluded.		
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Kamal, N., Holodinsky, J. K., Stephenson,	**Purpose**: To analyze four specific strategies to reduce door-to-	**Sample**: n= 350 patients admitted to ED and treated with tPA.	**Design**: Observational study using a prospective pre and post intervention design, while simultaneously	**Results:** Median door-to-needle times lower in each	**Discussion:** All four interventions associated with reduced door-to-

C., Kashayp, D., Demchuk, A. M., Hill, M. D.,…Smith, E. E. (2017). Improving door-to-needle times for acutie ischemic stroke: Effect of rapid patient registration,	needle times. Four strategies implemented: 1) single call activation of stroke team by EMS, 2) registering pt as "unknown" on arrival so that labs and imaging can be ordered, 3) stat transfer to CT scan, 4) administering tPA in CT scan.	In-hospital stroke patients and transfer patients excluded. **Setting:** Single site, academic medical center	controlling for each of the four strategies implemented. Project implemented in three phases: baseline data used from Jun. 6, 2012 to Jun. 5, 2014; implementation dates for three strategies from Jun.6, 2013 to Jan. 24, 2015;fourth strategy implemented on Jan. 25, 2015 to Jun. 29, 2015. **Intervention**: 3 changes were implemented: 1)single call activation of stroke team by EMS, 2) registering pt as "unknown" on arrival so that labs and imaging can be	time period: Phase 1=53 min, Phase 2=45 min, Phase 3=35min (*p*= .0002). Univariable analyses used for following 4 interventions: Median door-to-needle times for EMS notification (40 min vs 51 min; *p* <.0001). Registering pt as unknown	needle times. Direct transport to CT and administering of tPA in CT scan associated with largest reduction in door-to-needle times. **Limitations**: Single site study using a prospective design intervention control phase, not randomized Data not collected on why specific

movind directly to computed tomography, and giving alteplase at the computed tomography scanner. *Circulation: Cardiovascular Quality and Outcomes, 10,* e003242. doi.10.1161/			ordered, 3) stat transfer to CT scan, 4) administer tPA in CT scan, **Outcome Measure:** Door-to-needle time **Analysis:** These strategies were implemented in a staggered fashion and investigators were able to use multivariable regression modeling to determine the effect of each strategy. Wilcoxon rank sum and Kruskal-Wallis tests with multivariable linear	(40 min vs 53 min; p <.0001) 12% decrease in door-to-needle time (95% CI 3% - 20%). Moving pt to CT (28 min vs 48 min; P< .0001) 30% decrease in door-to-needle times (95% CI 16%-42%). tPA administration in CT scan (29	interventions were not used on patients during implementation date. Future studies needed for to understand why specific interventions not applied to patients.

circoutcomes.116.003242.			regression used for statistical analyses of door-to-needle times. Cook's distance and variation inflation factor used for collinearity between variables. Stata version 14 used for statistical analysis.	min vs 47 min; *p* =.0001) and 32% decrease in door-to-needle time (95% CI 38%-55%).	
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		SETTING	(DESIGN INTERVENTIONS OUTCOME MEASURES)		INTERPRETATION, LIMITATION OF FINDINGS
Tan, B.Y., Ngiam, N. J., Sunny, S., Kong, W., Tam, H., Sim, T. B.,…Yeo, L. L. (2018). Improvement in door-to-needle time in patients	**Purpose:** To evaluate the effect of a stroke activation protocol to reduce door-to-needle times, door to CT-time and functional outcomes.	**Sample:** n= 410 patients admitted to ED and treated for AIS. 129 patients in control group, 137 patients in protocol #1 and 144 patients in protocol #2. **Setting**: ED of a single, site hospital in Melbourne, Australia.	**Design:** Observational study comparing pre and post interventional groups. Project implemented in three study periods: 1) 129 patients in control group, 2) 137 patients in protocol 1 from Mar. 2015 to Feb. 2016), 3) 144 patients in protocol 2 from Mar. 2016 to Dec. 2016). **Intervention**: Protocol #1	**Results:** Stepwise reduction from control group to protocol #1 group to protocol #2 group (84 ± 47 minutes versus 69 ± 33 minutes versus 59 ± 37 minutes; *p*	**Discussion:** Various concurrent stroke protocols effectively reduced door-to-needle times. Introduction of 24-hr stroke nurse was important in expediting treatment protocol. Protocol

with acute ischemic stroke via a simple stroke activation protocol. *Journal of Stroke and Cerebrovasc ularDisease s, 27(*6), 1539-1545. doi.org/10.1 016/j.stroke cerebrovasdi s.2018.01.0 05			included: 1) EMS pre-notification of AIS patient, 2) direct transfer from ambulance to CT scan, 3) rapid neuro assessment in route to CT scan. Protocol # 2 included: 1) stroke nurse accompanied pt to CT scan, 2) completed neuro assessment, drawing labs, basic reading of CT scan 3) administers tPA in CT scan **Outcome Measures:** Door-to-needle times, door-to-CT times **Analysis:**	$<.001$) resulting in improved door-to-needle times. Reduction in door-to-needle time predominantly due to reduction in door-to-CT time (31 ± 37 minutes in control group, 14 ± 24 minutes	development took over 2 years to develop. **Limitations:** Single site study, results not generalizable. Only initial reduction of door-to-needle time presented as a result of various interventions. Future studies to evaluate strategies over longer period

			T tests for continuous variables. Chi-square used for analyses for categorical variables. Histogram plot to demonstrate distribution. *p*-value of ≤ 0.05 was used.	after protocol 1; 10± 25 minutes after protocol #2; *p* <.001). Protocol # 2 (144 patients) showed significant door-to-needle time reduction as compared to protocol #1 (137 patients) before (59±37 minutes versus	of time.

				69±33 minutes; p =.020. Higher percentage achieving target of 60 minutes (68.1% versus 48.2%, $p < .001$) Functional outcomes between protocol #1 and protocol #2 revealed no significant difference in stroke scale	

				score at 48 hours (9.1 versus 7.2, *p* = 0.76) good functional outcome rates, mortality or symptomatic intracranial hemorrhage (6.3% versus 2.2%, *p* =.093)	
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			INTERVENTIONS OUTCOME MEASURES)		LIMITATION OF FINDINGS
Threlkeld, Z. D., Kozak, B., McCoy, D., Cole, S., Martin, C. & Singh, V. (2017). Collaborative interventions reduce time-to-thrombolysis for acute	**Purpose:** To evaluate the effect of 11 collaborative interventions to reduce door-to-needle times.	**Sample**: n= 299 acute stroke patients evaluated in ED and treated with tPA. **Setting**: ED of a single site, academic, urban, public safety net hospital. Designated as a primary stroke center since 2006.	**Design:** Observational, retrospective, study comparing door-to-needle times pre and post implementation of targeted interventions for AIS pts from 2008 to 2015. **Interventions:** Interventions included: 1) standardized CT protocol, 2) Stroke coordinator, 3) tPA administered in CT, 4) stroke code activation, 5) dedicated	**Results:** Median door-to-needle times significantly reduced by 38 min (87 min to 49 min) post intervention (*p* < .001). Median door-to-CT scan to interpretation reduced by 28	**Discussion:** Organizations and patients are acknowledging importance of rapid treatment of tPA. 11 distinct interventions significantly decreased door-to-needle time. **Limitations:** Single, site study

ischemic stroke in a public safety net hospital. *Journal of Stroke and Cerebrovascular Diseases*, *25*(7), 1500-1505. doi:org/10/1016/j.jstrokecerebrovasdis.2017.03.004			ED pharmacist, 6) monthly peer review meetings, 7) mobile clot box, 8) supply care in CT, 9) standardized tPA administration by ED RN, 10) medicine dispenser in CT, 11) stroke code simulation **Outcome Measures:** Compared median door-to-needle times and median door-to-CT scan to interpretation the pre-intervention group (n=67) and post-intervention (n=66) group.	min (41 min to 13 min) post intervention ($p < .001$). Post-intervention patients receiving tPA within 60 minutes of arrival increased with our interventions from 9% (95% confidence interval: 5%-	with 24-hour inhouse availability of neurology consultation, thus not generalizable. Future studies needed in public safety net hospitals and the effect of applied interventions on in-hospital mortality or functional outcome.

			Analysis: *T* test and Wilcoxon rank-sum tests were used for statistical analyses of median door-to-needles and median door-to-CT scan to interpretation. Significance was defined as $p < 0.004$. Bonferroni correction was used for multiple comparisons.	22%) to 70% (58%- 81%, P < .001). Interventions associated with greatest improvement in door-to-needle times: 1) stroke activation system, 2) dedicated pharmacist in ED, 3) mobile clot box.	

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			MEASURES)		
Xian, Y., Xu, H., Lytle, B., Blevins, J., Peterson, E. D., Hernandez, A. F.,…Fonarow, G. C. (2016). Use of strategies to improve door-to-needle times with tissue type	**Purpose:** To analyze hospital strategies to reduce door-to-needle times after Target: Stroke and quantify associations with door-to-needle times.	**Sample**: n=16901 AIS pts treated with tPA within 4.5 hours of symptom onset. **Setting:** n=888 hospitals who are enrolled in the GWTG-Stroke registry	**Design:** Survey Cross-sectional study of GWTG-Stroke hospitals. **Procedure:** Survey of participating hospitals and their use of Target: Stroke key practice strategies using a 0% to100% of the time scale or a binary yes/no from Dec. 2014 to Apr. 2015. Individual pt data obtained from GWTG stroke registry. Timeframe of 16901 stroke	**Results:** Hospital median door-to-needle time was 59 min (IQR, 51-71). 521/888 (58.7%) hospitals achieved door-to-needle times within 60 minutes. Pt level median door-to-needle time was 56	**Discussion:** Surveyed hospitals reported moderate to extensive use of Target: Stroke best practices. Study suggests that door-to-needle times could be effectively reduced with simple policy changes. **Limitations**: Survey based research study and

plasminogen activator in acute ischemic stroke in clinical practice. *Circulation: Cardiovascular Quality and Outcomes,10,* e003227.doi.10.1161/CIRCOUTCOMES.116.003227			pts treated with tPA was Jun. 2014 to Apr. 2015. **Outcome Measures:** Total of 16 strategies associated with significant reductions in door-to-needle times. Strategies used less frequently: 1) direct transport to CT scan, 2) pre-mix of tPA ahead of time, 3) administration of tPA in CT scan, 4) prompt data feedback **Analysis:** Multivariable linear regression models used to analyze relationships	min (IQR, 42-75). Median percentage of hospitals who did direct to CT transport was 40% (IQR, 0-95; *p* <.005). 59% of pts received tPA within 60 min and 30.4% within 45 min of hospital arrival. Phase I Target: Stroke survey-	participating hospitals self-reported information Surveys were voluntary (61% response rate) Survey results not generalizable to hospital population. Future studies are needed to evaluate impact of safety and outcomes with increased used of these strategies.

			between door-to-needle time and strategy.	median door-to-needle time decreased from 72 min (IQR, 55-94) to 56 min (IQR, 42-75) min in Target: Stroke Phase II. Percentage of pts with door-to-needle <60 min increased from 33.9 (1849/5460) before Target: Stroke to 59.3%	

				(10020/16901) had door-to-needle times <45 min. Total of 20 min (95% CI; 15-25 min) could be saved if all strategies implemented.	