Winter 12-15-2017

Saving the Brain Matter(s): Improving Stroke Outcomes Utilizing a Direct to CT Workflow

Robert Schambach
rsschambach@usfca.edu

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Robert S. Schambach

University of San Francisco

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Clinical Leadership Theme

"Saving the Brain Matter(s): Improving Stroke Outcomes Using a Direct to CT Workflow" was a project undertaken to improve door to alteplase administration times for acute stroke patients at a rural, certified primary stroke center. Leadership themes that are applicable to this project include the clinical nurse leader's (CNL) role as a facilitator of lateral integration, educator of evidence based best practices and as a team leader for improving patient outcomes through process improvement.

This project required an interdisciplinary approach as the initial care of an acute stoke patient requires a complex web of activity by the registration, nursing, medical staff, respiratory, laboratory, radiology information technology and administration departments. A key component for the project was creating buy-in for the change with the many stakeholders. Providing evidence based education that focused on the ability to improve outcomes through rapid alteplase administration was a key component for creating buy-in for the change. Lean methodologies along with the plan, do, study, act (PDSA) process were utilized to model and improve the workflow for acute ischemic stroke patients.

CNLs don't necessarily manage people, they manage care. The challenge of improving door to alteplase time greatly benefits patient outcomes and the initial care of ischemic stroke patients generally occurs within the microsystem of an emergency department (ED) (Jauch et al., 2013). These facts place the problem within the prevue of a CNL.

Statement of the Problem

Stroke is the fifth leading cause of death in the United States and is the cause of one in every twenty deaths. 795,000 people every year experience a stroke and 87% of these strokes

are ischemic. Additionally, stroke is a leading cause of disability in the United States (Benjamin et al., 2017). The only FDA approved treatment for ischemic stroke, available to primary stroke centers, is intravenous alteplase (Bansal, Sangha and Khatri, 2013). Time is critical when stroke strikes. As onset to treatment time (OTT) increases in-hospital mortality, symptomatic intracranial hemorrhage, non-independent ambulation at time of discharge and discharge to locations other than the patients home all increase as well (Saver et al., 2013).

Door to needle (DTN) time for intravenous (IV) tissue plasminogen activator (alteplase) administration at the facility historically averaged 67 minutes. Applicable clinical practice guidelines (CPG), for ischemic stroke that were applicable to this project, were last published by the American Heart Association (AHA) and American Stroke Association (ASA) in 2013. These guidelines indicate that DTN time for alteplase should be less than 60 minutes to maximize a patient's opportunity for a non-debilitating outcome (Jauch et al., 2013). To improve ischemic stroke patient outcomes at the facility, a process improvement project to decrease DTN time for alteplase to less than 60 minutes was initiated. The primary metric monitored for the project was door to needle time for alteplase administration.

In addition to publishing many of the CPG the American Heart Association also created the Get With The Guidelines (GWTG) program for stroke to encourage and recognize excellence in stroke care. The Target: Stroke portion of the GWTG program recognizes facilities that meet benchmarks related to door to alteplase administration times. The highest level of recognition in the Target: Stroke program is the Elite Plus level which is awarded to facilities that administer alteplase within 60 minutes of arrival 75% of the time and within 45 minutes of arrival 50% of the time.

Rationale

The 2013 update to the AHA/ASA Stroke CPG for alteplase use in treatment of ischemic stroke patients eliminated many recommendations for screening, testing and inclusion requirements that had historically been required prior to the administration of alteplase. The original rationale for the eliminated guidelines was based on the initial studies performed to prove that alteplase was effective in reducing disability in patients who suffered ischemic cerebrovascular events. These initial studies were necessarily strict in their inclusion and exclusion criteria as the use of the drug was investigatory and catastrophic outcomes, involving intracranial or systemic hemorrhages, had been well documented (Zivin, & Simmons, 2011). The 2013 revisions to the clinical practice guidelines for stroke relied on extensive research into the efficacy and safety of alteplase as its use became more common.

The changes to the CPG included elimination of coagulation, hematological, troponin, or other biochemistry testing prior to alteplase administration. Testing was still recommended, but only if it did not delay initiation of IV alteplase administration. With the new CPG the only laboratory or bedside testing required was an assessment of blood glucose levels prior to the initiation of alteplase (Jauch et al., 2013). Other changes to the CPG included no delay for IV alteplase administration to assess a baseline electrocardiogram or perform chest radiography (Goldstein, 2007).

The evidence based changes to stroke CPG allowed for workflows that could provide accelerated treatment for patients presenting to emergency departments with ischemic stroke. At the facility, the order to result time for troponin averaged 64 minutes due to the blood analyzer utilized. Similarly, coagulation studies order to result times averaged greater than one hour. If the specimen required dilution and retesting, the coagulation studies often took longer than 90

minutes. Removing the requirement for lengthy blood testing opened a window where more rapid assessment, screening and treatment of acute stroke patients seemed possible.

Stroke related services currently generate five million dollars in revenue for the facility annually. Compliance with national guidelines is critical to maintaining certification as a primary stroke center and remaining eligible to receive 911 stroke patients from the County Emergency Medical System. The estimated direct and indirect costs of the proposed performance improvement plan, education, implementation and tracking was 22,000 dollars (See Appendix A). The costs were solely salary based and included planning, education and training involving all of the interdisciplinary team members that cared for stroke patients. Additional training was not anticipated to be necessary but, if there was difficulty implementing the new process, a second round of training, meetings and education were considered as part of the PDSA cycle. The cost of a second round of training was estimated to be less than 6,000 dollars.

System Setting

The facility contains a small, eight bed, rural emergency department that sees 29,000 patients per year. Certification as a Primary Stroke Center (PSC) is one of the few specialty service lines that the hospital offers. Certification as a PSC was obtained after the County Emergency Medical System (EMS) set a goal to have all 911 receiving hospitals located within the County become stroke receiving centers. The facility rose to this challenge and recruited the only neurologist practicing locally to champion the effort and assume the role of Stroke Medical Director. An interdisciplinary team was set up and the journey toward certification was started. Early on leadership at the facility realized that only the relatively new field of telemedicine would allow the facility to fulfil the acute neurology requirements of a Primary Stroke Center. Telemedicine options were researched and the facility began the first tele-neurology program in

the region. Eighteen months later and after a successful three-day initial survey of the program, the Joint Commission awarded the facility hospital certification as a Primary Stroke Center.

Despite many successes, a persistent DTN time of over 60 minutes remained one of the primary challenges for the program. Emergency department providers, nurses and ancillary services had worked for years to drive DTN times down with limited success.

After the release of the revised CPG, many within the medical community, including physicians and nurses at the facility, were reluctant to change their clinical practice or support any revision of their current stroke policies and workflow. When this project was first proposed to the core stroke committee resistance was analyzed and it was found that the primary reason for not wanting the change was rooted in the historical education and training clinicians had received. Clinicians told stroke committee members stories and referenced studies highlighting the potentially lethal or debilitating risks of alteplase. Many felt the extensive battery of tests and assessments currently in place were essential to prevent harm to patients in their care. The new stroke CPG asked clinicians to accept evidence that alteplase, a drug viewed by one physician, “as the nuclear option of thrombolytics”, should be given to their patients without first determining their patient’s PT or PTT. No platelets from a complete blood count. No electrocardiogram. No troponin. No chest x-ray. “No alteplase!” was the response from many providers. Suddenly the safety net of testing and screening that clinicians had been told would keep their patients safe from harm had been removed.

Methodology

The global goal of the project was decreasing door to needle time (DTN) for alteplase administration in acute ischemic stroke patients to under 60 minutes. The new guidelines were summarized and presented to the Core Stroke Committee and Emergency Services Department

meetings for evaluation. After review and consideration, the Medical Director of the Stroke Program and the Chair of Emergency Medicine agreed to champion the new CPG. The new CPG and the opportunity for change was presented to the Emergency Department Performance Improvement Committee (EPIC), an interdisciplinary team that meets monthly. This interdisciplinary team performed a comprehensive review of the stroke alert workflow (see Appendix B for detail on the historical workflow). The review also included the evaluation of the historical order to result times for common pre-alteplase testing and screenings. After the EPIC team modeled the historical workflow the team removed the steps no longer required under the new CPG. Even with the laboratory studies and other CPG testing removed it was evident to the team that it would still be very difficult to administer alteplase in less than sixty minutes without extensive changes to the historical workflow. Work began on modeling a safe method to get the Emergency Department Medical Doctor (EDMD) and Neurologist the information necessary to make a go or no-go decision to administer alteplase.

The EPIC and Core Stroke Committees also discussed improving the patient education, consent process and family involvement for acute stroke patients. It was established that to provide ischemic stroke patients with the best chance of a non-debilitating evaluation and treatment does needs to be rapid. However, it was also decided that ensuring that the risks, benefits and treatment options were fully understood by the patient and their loved ones was of equal importance. It was during discussions on how to increase patient and family involvement in clinical decision making that the idea of, formally, assigning all stroke alert patients two RN's until a go / no-go decision had been made was raised. Once proposed, this idea gained traction rapidly. Through workflow modeling it became evident that the historical workflow divided naturally into two clearly defined pathways for two RN's. Two RN's working in parallel would

greatly increase both the speed of the evaluation, treatment and documentation as well as the education and care of the patient and their family. Concerns about a need to increase staffing were discussed but dismissed since historically acute stroke patients already had two RN's during the initial triage and treatment phases of their visit. The benefit would be found in formalizing the practice and in scripting each RN's efforts within the new project workflow.

Considerable discussion and planning was focused on overcoming the fragmented nature of the information technology (IT) environment at the facility. Registration, the ED electronic health record, the radiology processing system, the radiology storage system and the inpatient EHR are all on disparate systems that work together through a complex interface application. Because of this complex IT environment most patient documentation must be done in a serial fashion. Triage cannot be documented until registration is completed. Orders and EDMD documentation cannot be entered until triage is completed. For triage to be completed a full set of vital signs must be entered into the chart. Furthermore, radiology orders entered in to the ED EHR have a delay of minutes until they are processed and received by the radiology IT systems. The EPIC team examined the average time to complete (ATTC) each of these, sequentially serial, tasks that had to be completed under the historical workflow before alteplase could be administered. Physical movement time was included in the ATTC for each task. It was estimated that, on average, registration required seven minutes, triage nine minutes, EDMD evaluation eight minutes, EDMD CPOE five minutes, order interface processing time two minutes. The total average ATTC for the basic documentation required to order a non-contrast head CT totaled twenty-six minutes, almost half of the sixty-minute target for alteplase administration. This left only thirty-four minutes to transport the patient to CT, scan the patient, return the patient to the ED, comprehensively obtain and document the patient history, physical

and assessment, start a second IV, and a multitude of other tasks before alteplase could be safely administered. It was clear radical changes needed to be made to the historical workflow but the team was unsure of what this change would look like.

During the Pacific Stroke Association's annual Regional Stroke Conference another local Emergency Department presented two case studies, that had drastically decreased door to alteplase times, by having EMS take suspected stroke patients directly to the CT scanner (2015). This idea was presented to the EPIC team and Core Stroke Committee. The consensus that both committees reached was that a direct to CT workflow had the potential to overcome many of the delays the historical workflow contained. After meeting with radiology leadership and technologists it was discovered that a CT could be performed on a patient without registering the patient, creating an EHR, triaging the patient and entering an order into the EHR. CT technicians could manually enter the patient name and date of birth directly into the scanner and later, once the EHR was created, append the CT scan into the medical record. Obtaining this knowledge was an important step in realizing the specific aim of the project. The team now knew that many of the perceived barriers for a direct to CT model could be overcome.

A new workflow for the nursing and medical staff was developed and presented at EPIC and the Core Stroke Committee (see Appendix B for a comparison of the project workflow to historical workflow). The new project workflow formalized the idea that two nurses with detailed responsibilities were to be assigned to all stroke alert patients (See Appendix C for information on the division of responsibilities). The EDMD and primary nurse would screen the patient immediately upon arrival and EMS would take the patient directly to the CT scanner.

In order to realize this workflow radiology, registration and other ancillary departments that responded to a Stroke Alert needed to be involved in the process change. Formal and

informal meetings were held to determine what processes registration followed when patients arrived and what was required by radiology technologists to safely perform a non-contrast head CT.

Meetings with registration focused on two areas, rapid registration upon arrival and ensuring the accuracy of the information being entered. If a patient was to get a head CT without first being registered it was critical that the patient be properly identified and the data entered by both the CT technician and registration clerk be synchronous and accurate. Discussions with leadership identified that registration could use any workstation within the hospital to complete a registration. Registration leadership and staff members also suggested that the CT technician and registration clerk work together, in the same physical space, to limit the chance of errors. The CT control room was large enough to accommodate a workstation on wheels and it was proposed that the registration clerk complete initial registration in the CT control room as the CT technician was initializing the scanner and entering the patient data into the CT scanner. A double check system, where the CT technician checked the registration clerks' data and the registration clerk checked the CT technicians' data was discussed.

After ensuring that radiology and registration could technically and safely implement a direct to CT model department champions were identified. These department champions joined the project team as planning moved forward.

The team's attention turned to physicians and developing an algorithm to ensure that non-contrast head CTs would be safe and medically necessary. ED physicians and the core stroke team examined two core questions. First, how would patients be screened by the physicians and what criteria would be used? Secondly, how would an order be generated, communicated and documented and finally, how would patient consent be handled? To answer these questions, it

was necessary to examine the protocols and processes used by Santa Clara County EMS in identifying potential stroke patients in the field. To better understand these protocols and processes the team met with paramedic and pre-hospital leadership from Santa Clara County.

Santa Clara County utilized a modified Cincinnati Scale to identify patients who maybe suffering from a stroke. The traditional Cincinnati Scale utilizes the commonly known by the mnemonic FAST screens for Facial droop or asymmetry, Arm or extremity weakness, Speech dysarthria, aphasia or apraxia and time since onset (Aroor, Singh, & Goldstein, 2017). To identify posterior strokes, with foci in the cerebellum, BE for Balance or ataxia and Eyes for diplopia were added to the prehospital screening in 2012 (Aroor, Singh, & Goldstein, 2017). Upon identification of a suspected stroke patient the receiving Stroke Center is notified by a process referred to as a ringdown. A ringdown is direct communication between the on-scene or en route paramedic and an RN at the receiving facility. A brief report is given and an estimated time of arrive communicated. Internal St. Louise data indicated that 62% of stroke alert ringdowns from EMS were coded as a hemorrhagic or ischemic stroke upon discharge or transfer. Data also showed that, historically, 88% of EMS stroke alert ringdown patients received a non-contrast head CT during their ED visit. With this knowledge, the team reconvened and discussed options for ED physician screening upon arrival to the ED.

After much discussion, it was proposed by the ED physician champion that patient screening on arrival be primarily focused on hemodynamic stability. Patients who were unstable would be identified and stabilized in the ED prior to CT testing. It was proposed that the ED physician meet the ambulance crew at the ambulance bay doors and utilize EMS vital signs and a rapid survey of the patient to determine hemodynamic stability. Secondary screening was

focused on ensuring the medical necessity of a CT scan. It was also at this time that consent for testing was to be obtained.

Synthesis of these meetings lead to the development of a multi-departmental implementation plan. Registration trained all ED clerks to quick register patients using the best available data in the CT control room with the CT technician present. Both individuals would be actively involved in double checking data.

Radiology CT technicians were trained on how to initiate a scan without an order being present in the scanners work queue. Technicians also needed education on entering patient data directly into the CT scanner and confirming all patient data with registration personnel.

ED physicians required education on the new workflow, hemodynamic, medical necessity and consent screenings. This was implemented at the ED Department meeting by a unanimous vote of the attending physicians. Education was accomplished by the contracted ED physician group internally.

ED nursing received workflow training focused on assisting EMS to CT and following the patient and team with a weigh gurney and portable cardiac monitor. After EMS transferred the patient to the CT scanner cardiac monitoring would be switched over to hospital equipment and care coordination between the nurse and EMS personnel would continue. Historical training focused on the first 15 minutes of a patients visit and many of the priorities previously utilized would change. The roles of the primary RN and second, assisting, RN were also reviewed. Training took approximately thirty minutes per RN.

Copies of the new project workflow were placed in the ED department stroke packets for reference. The stroke packet contains the detailed workflow with division of labor (see

Appendix B), a National Institute of Health Stroke Scale reference tool, and a stroke core measure check off sheet.

To ensure patient safety, training for physicians, nursing and radiology technicians included material to empower them to call for a hard stop and comprehensive reevaluation of the patient and course of care at any time in the direct to CT process.

The County EMS was formally notified that the hospital was moving to a direct to CT model for stroke alert ringdowns and education was disseminated for pre-hospital care providers on the new workflow.

Finally, all involved were again educated as to why the new workflow was being implemented. It was presented or reviewed at staff meetings, shift huddles or one on one. Feedback was collected and communicated back the project leader, EPIC or Core Stroke committee.

Data Source and Literature Review

As a primary stroke center St. Louise collects hundreds of data points on each stroke patient cared for by the facility. Data is collected and aggregated in a national database for analysis and reporting. Interrater reliability is tracked and maintained. Confidence in the data set is critical as it is used for certification and validation of the stroke program. For this change the overall measure of success would be door to alteplase administration time. Additional metrics would be tracked included door to CT time and CT study to radiologist interpretation. All other stroke data collection continued and variations in metrics over time examined by the Stroke and EPIC committees to determine if the direct to CT model was positively or negatively affecting patient care.

Timeline

This project was implemented over a 10-week period. The expected cost of implementation was lower than projected since much of the planning and workflow revision was accomplished during the regular, monthly, EPIC and Stroke committee meetings. Education on the new workflow took only thirty minutes as opposed to the hour estimated. No formal post implementation training was required.

Results

The results of the project change were immediate, positive and met the aim of decreasing door to needle time for alteplase to less than sixty minutes. After implementation of the project workflow the mean door to alteplase time dropped to less than 45 minutes. Many ischemic stroke patients received alteplase in less than thirty minutes from their time of arrival (see Appendix E for results data). The results of the process change were sustained and the project workflow is currently still in use with minor changes.

The facility was recently recognized by the American Heart Association's Target: Stroke program at the highest, Elite Plus, level for sustained excellence in ischemic stroke care. Patient outcome data, as measured by the modified Rankin score, is currently being aggregated to compare 30 and 90-day outcomes for patients treated before and after the direct to CT workflow was implemented.

Nursing Relevance

Ischemic stroke is the leading cause of disability in the United States. Studies are clear that the faster appropriate medical intervention occurs after the onset of stroke signs and symptoms the more likely it is that a patient will recover from the stroke without significant disability.

Medical intervention for stroke is complex and specialized. All the roles of a Clinical Nurse Leader are needed to plan, implement, evaluate and assess an emergency department microsystem that provides acute stroke care. This project focused on improving the interdisciplinary continuum of care but the techniques used and the lessons learned are applicable to any microsystem change project. Research and knowledge of current evidence based practice are the foundation of any CNL microsystem intervention. The CNL role of outcome manager was used to define a clear, measurable objective. The role of educator and team leader was the foundation for effectively educating leadership, medical staff, peers and subordinates which provided motivation for the microsystem healthcare providers to improve care. Once the motivation for change was present the project utilized two theories of change, LEAN principles and the PDCA cycle. These change paradigms provided the CNL, project team leadership and team members with the apparatuses and methodologies necessary to evaluate the complex workflow required for acute ischemic stroke care and then develop a new process to affect door to needle time. Strong horizontal leadership is critical to improving the lateral integration of patient services within any microsystem and this projects success is largely due to the interdisciplinary Emergency Department Performance Improvement Committee. Ultimately, the goal of this project is found within the CNL role of outcome management.

This project is generalizable to many primary stroke centers that are interested in improving ischemic stroke outcomes by administering alteplase swiftly after the patient arrives to the facility. The project is directly applicable to emergency departments that utilize tele-neurology services to assist emergency room physicians in the evaluation and management of ischemic stroke patients. However, facilities with on-site neurology should be able to improve door to needle time for alteplase even more than the times this project was able to achieve. This

can be achieved by having the neurologist meet the stroke team, EMS and the patient in the CT suite. With the neurologist present alteplase could be ordered shortly after the non-contrast head CT has been performed. All the medication and equipment necessary for administration of alteplase and the immediate management of the ischemic stroke patient could be stored in, or brought to, the CT suite. After administration the patient would be brought to the emergency department for the first time. This workflow should be able to provide door to needle times as low as fifteen minutes.

Summary Report

The project "Saving the Brain Matter(s): Improving Stroke Outcomes Using a Direct to CT Workflow" was initiated with the aim of improving door to alteplase administration times for acute stroke patients at a rural, certified primary stroke center. The specific patient population for this study included, and continues to include, all patients presenting to the facility emergency department within four hours of the commencement of signs or symptoms of stroke.

Implementation of the project involved researching the clinical practice guidelines for the treatment of ischemic stroke and the strategies used to improve stroke team performance. Educating staff and providers about the reason the change was important and necessary was the information that held the most gravitas for creating buy in for the change. It was also valuable to review the door to needle time for alteplase administration at the facility and discuss how the historical average of 67 minutes was above the 60-minute target found in the clinical practice guidelines. These facts provided motivation for the teams to work on implementing the project and assist with the change process.

The project primarily used Lean methodologies along with the plan, do, study, act (PDSA) process to model and improve the workflow. Ishikawa and SWOT diagrams were also

utilized for the project during the early planning stages (see appendices C and F for the diagrams). Both tools provided valuable insight for the teams and helped focus efforts on creating a direct to CT workflow that was as lean as safety allowed.

The results of the project change were immediate, positive and met the aim of decreasing door to needle time for alteplase to less than sixty minutes. After implementation of the project workflow the mean door to alteplase time dropped to less than 45 minutes, with many patients receiving alteplase in less than thirty minutes from their time of arrival (see Appendix C for results data). This 22-minute reduction in door to needle time exceeded our initial target of seven minutes. To ensure the results of the process change were sustained workflow for acute stroke patients is reviewed, at a minimum, annually during department skills days. Graphs of door to needle time are also posted on visibility boards to keep frontline staff and providers aware of the target and how the facility is performing. Finally, the stroke coordinator awards small lightning bolt pins to stroke team members who participate in the care of a stroke patient if the door to alteplase time is less than forty-five minutes. These pins are often worn by stroke team members on their badges and are an easy but appreciated way to recognize excellence in clinical care. The project workflow has been modified slightly since implementation and is currently in use. Earlier in the year the facility was awarded Target: Stroke Elite Plus level recognition by the American Heart Association. Target: Stroke Elite Plus is the highest level of recognition a facility can receive. It is awarded to facilities where the door to needle time is less than 45 minutes 50% of the time and less than 60 minutes 75% of the time.

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Appendix A

Financial Analysis

Annual Stroke Labor Expense	
Stroke Coordinator Labor Cost	$139,776
Annual Cost of Education	$60,480
Medical Directorships	$50,000
Teleneurology Contract	$150,000
Stroke Committee Meetings	$7,168
Stroke Service Line Labor Expenses	**$400,256**
Data	
Stroke Alerts (Annually)	600
Stroke Alert Conversion (Admission) Rate	0.34
Benefit multiplier	1.4
Hourly Rate	$80
Average Revenue / Charge	18%
RN Annual Education Hours	4
RNs Stroke Trained	135
Stroke Coordinator FTE	0.6
Stroke Coordinator Annual Hours	1248

Stroke Charges and Revenue (ICD-10 160-169)				
	Per Patient	Annualized		
Per Patient ED Charges	$18,000	$3,672,000		
Per Pateint Inpatient Charges	$120,000	$24,480,000		
Median ED Revenue	$3,240	$660,960		
Median Inpatient Revenue	$21,600	$4,406,400		
Gross Revenue	**$24,840**	**$5,067,360**		
	Hours	Number Trained	Facility Cost/Hr	Total
Workflow Team Planning	12	8	$70	$6,720
Direct to CT Initial Education				
RN	2	50	$80	$8,000
Radiology	2	22	$80	$3,520
Registration	1	25	$80	$2,000
Lab	1	12	$80	$960
Cardiopulmonary	1	10	$80	$800
			Grand Total	$22,000

Appendix B

Stroke Alert Workflow Comparison

Historical Workflow	**Project Workflow**
911 Ringdown	911 Ringdown
One RN Assigned	Two RNs Assigned/EDMD Notified
Radiology CT Tech Notified	Radiology CT Tech Notified
Registration Notified	Registration Notified
Room Prepped	EDMD and RN Meet EMS at Ambulance Door
Stroke Alert Called Upon EMS Arrival	EDMD Screens for Hemodynamic Stability
Patient to Room Placed on Gurney	EDMD Evaluates Signs and Symptoms of Stroke
Report from EMS	EDMD Gives Verbal Order for Non-Contrast Head CT
Patient Registered	EDRN Accompanies Patient with EMS to CT on EMS Gurney
Patient Vital Signs Obtained	EDRN Brings ED Scale Gurney and Portable Monitor to CT
Patient History Obtained	Registration, CT Tech and RN Verify Patient Identity
Triage Completed (After Registration Completed)	Registration Registers Patient
Complete EDMD Evaluation, H&P	CT Tech Enters Patient Data Directly into CT
Labs Drawn	CT Tech Performs Non-Contrast Head
EDMD CPOE CT Order	CT Completed Available for Telenuero/EDMD
Patient Placed on Portable Monitor	EDRN Obtains Report from EMS In CT
Patient Transported to CT	ED Clerk Calls Teleneurology
CT Obtained	Second RN Preps Telemedicine Cart
Patient Transported to ED	Second RN Brings Alteplase to Bedside
CT Results Obtained	Patient Transported on ED Gurney to ED
Teleneurology Contacted	Stroke Alert Called Upon Return from CT
EDMD to Neurologist Consult	EDRN One Completes Triage, NIHSS,Assessment
Teleneurology Exam by Neurologist	EDRN Two Starts Second IV, Monitor, Weight
EDMD and Neurologist Consult	Complete EDMD Evaluation H&P
Lab Results Obtained, CXR Results, EKG	EDRN Calculates Alteplase Dose and Preps Drug
Order for Alteplase	Ancillary Departments: Draw Labs, EKG, CXR
Alteplase Pulled	EDMD to Neurologist Consult
Alteplase Mixed, two RNs verify	Teleneuro Exam EDMD at Bedside
Alteplase Administered	Order for Alteplase
	Alteplase Mixed, two RNs Verify
	Alteplase Administered

Appendix C

Primary and Secondary RN Stroke Alert Roles

(Facility) ED Stroke Alert

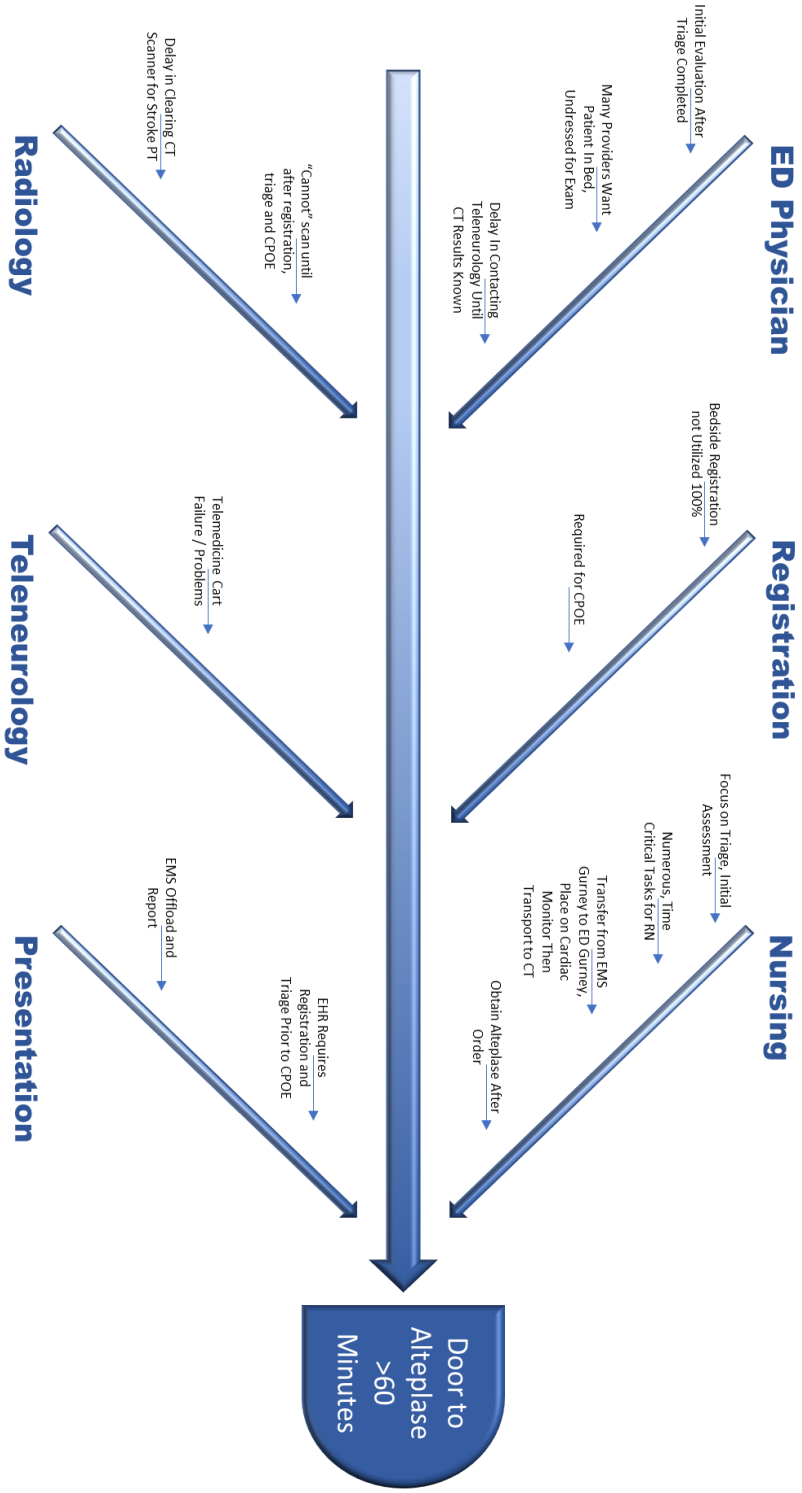
CRITICAL ASSESSMENTS AND INTERVENTIONS

Primary RN	Documentation RN
Assess with EDMD at ambulance bay doors	**Take ED gurney to CT with Monitor**
Obtain verbal order for CT and patient consent for treatment	**Obtain tPA and bring to bedside** **Stoke Packet to bedside**
If no field blood glucose, obtain	**Document Triage and Assessment**
Accompany EMS to CT	**Obtain/document Pt. Weight**
Pt. back to ED on ED Gurney	**Document IV 's**
Establish Last Know Well Time	**ECG monitor strip posted**
IV x2 and Draw for Labs	**Document Oxygen**
NIHSS	**Document Monitor**
Patient and Family Education	**Doc. Swallow Evaluation**
Neuro check(s) q30	**Record quality metric times**
Assist with Tele-neurology Eval	
Keep MD informed of changes	

Anticipate Alteplase: Be ready to give with <u>Every Patient</u>

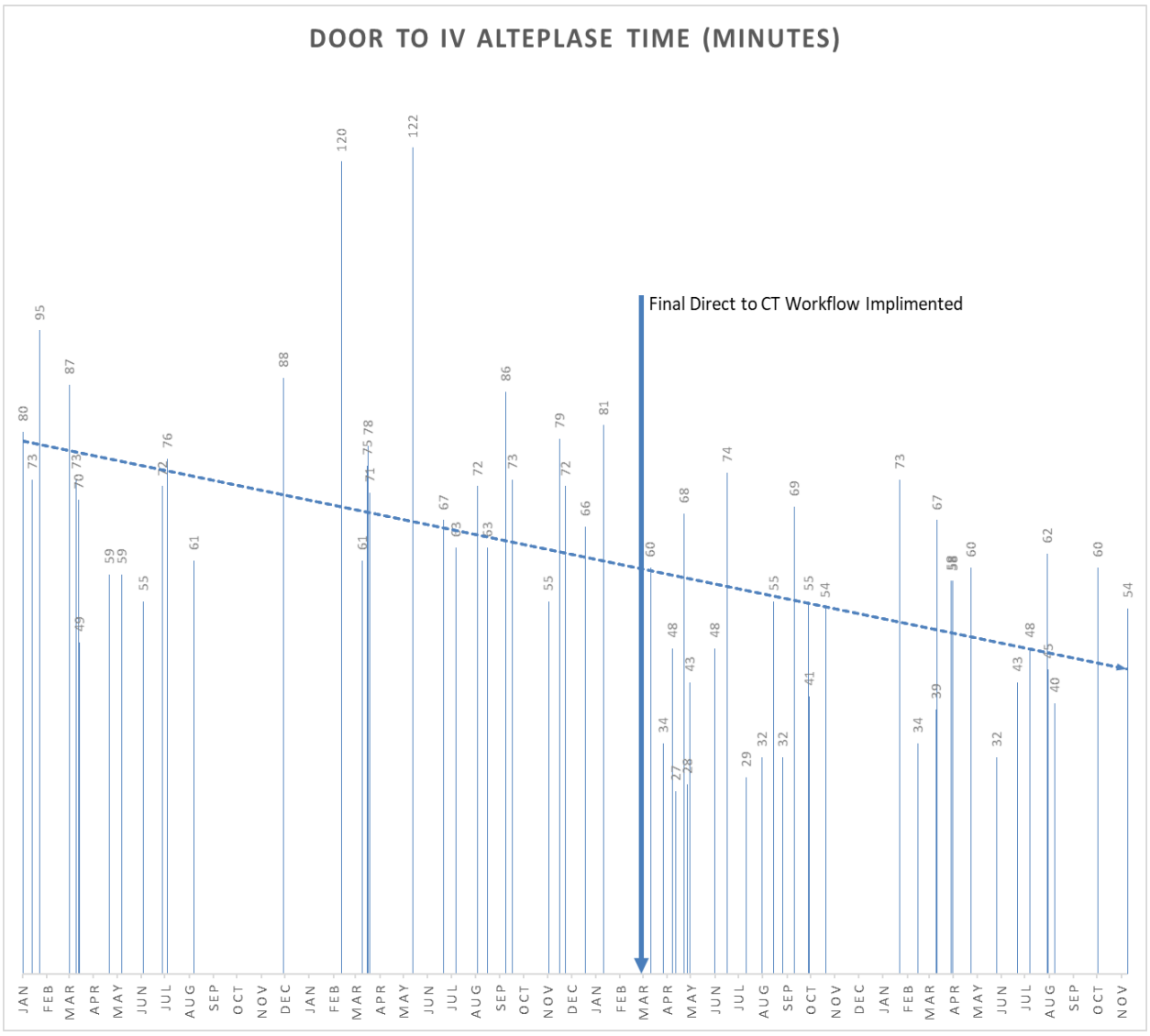
Appendix D

Cause and Effect Diagram



Appendix E

Historical and Results Data



Appendix F

SWOT Diagram