Southern California CSU DNP Consortium

California State University, Fullerton
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THE IMPLEMENTATION OF THE CODE STROKE PIT STOP: A QUALITY IMPROVEMENT PROJECT FOR GREATER EFFICIENCY

A DOCTORAL PROJECT

Submitted in Partial Fulfillment of the Requirements

For the degree of

DOCTOR OF NURSING PRACTICE

By

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May 2024

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DOI 10.5281/zenodo.13737643

ABSTRACT

Despite recent medical advancements to reduce the devastating morbidity and mortality outcomes commonly associated with ischemic stroke, there remains a disparity in access to these lifesaving interventions. The benefits of these advanced stroke interventions are profound and proven by the robust evidence in landmark studies conducted at high-performing academic medical institutions. However, the literature shows these interventions improve clinical outcomes when implemented by highly efficient systems-based processes. The code stroke process is the emergency department (ED) response system for acute stroke patients and the target area for streamlining quality improvement for efficient throughput to the appropriate intervention. This doctoral project aims to improve the efficiency of the stroke response process in the community hospital setting. The STAR module was applied to bridge the evidence into practice and nurture the needed cultural shift at the 377-bed community hospital. The optimized workflow was developed using the best evidence and shared experiences, and 12 ED quality/stroke nurses and approximately 60 ED staff nurses were trained. After implementing the optimized code stroke process, the desired outcomes were improved standard benchmark stroke performance data. The outcome performance data revealed overall improvement in performance and clinically significant improvement in stroke intervention performance. The successful implementation of an innovative code stroke process, called the code stroke pit stop, yields an opportunity to help drive improvement efforts at the community hospital setting seeking to advance the stroke program.

Keywords: stroke, large-vessel occlusion (LVO), mechanical thrombectomy (MT), nursing, code stroke pit stop, emergency department (ED), stroke performance, systems-based process, quality improvement, access, emergency medical services (EMS)

TABLE OF CONTENTS

Background

Stroke is a devastating disease most often resulting in disability or death. In 2019, the World Health Organization (WHO) named stroke the second leading cause of death globally (WHO, 2020). Stroke is the fifth leading cause of death in the United States (U.S.) but continues to be a leading cause of long-term disability for adults (Centers for Disease Control [CDC], 2022). The CDC estimated $53 billion in stroke-related costs in the U.S. between 2017 and 2018, accounting for medical services, stroke treatment medicine, and missed workdays (CDC, 2022), not accounting for the extent of the socioeconomic burden of the severe long-term disability caused by stroke. When stroke victims are treated in hospitals with organized stroke response systems, they are more likely to recover with minimal to no disability (Albers et al., 2018; Campbell et al., 2015; Fransen et al., 2016; Saver et al., 2015).

The Food and Drug Administration (FDA) approved intravenous alteplase (iv tPA) for treating acute ischemic stroke (AIS) in 1996 (U.S. Department of Health and Human Services, n.d.). Adoption of the thrombolytic drug as the standard of care for ischemic stroke with the development of certified stroke programs has shown a steady increase in iv tPA treatment rates from only 2% in 2000 to 9.9% in 2006, to 21.8% in 2018 of strokes who received iv tPA (Marko et al., 2020).

The administration of iv tPA has shown favorable outcomes and potentially a shift in stroke-related death rates in the U.S. However, there are constraints with iv tPA, such as a narrow window to treatment of 4.5 hours from symptom onset, the risk of cerebral and systemic hemorrhage, and the ineffectiveness of enzymatic digestion of large thrombi (Saver et al., 2015). Large thrombi strokes or large-vessel occlusions (LVO) settle in the proximal, larger cerebral arteries restricting perfusion to more significant territories of the brain tissue and are associated with more devastating deficits and higher mortality when compared to non-LVO strokes (Malhotra et al., 2017). LVO strokes are often refractory to iv tPA with less than a 10% success rate in lysing the clot (Albers et al., 2018). Therefore, the minimally invasive endovascular, non-pharmacological, reperfusion procedure called mechanical thrombectomy (MT) arose as the ideal intervention for removing the obstruction to regain cerebral perfusion.

Ideally, reperfusion is achieved as soon as possible to minimize the extent of brain tissue death in the presence of an AIS. The standard pathway to rapid reperfusion begins with the early activation of emergency medical services (EMS) by calling 911 when a stroke is suspected. Allowing EMS to route stroke victims to the closest, most appropriate hospital is critical because not every hospital is equipped to give iv tPA, and fewer are MT-capable; “every 30 minutes, a stroke patient who could have been saved dies or is permanently disabled because they were treated in the wrong hospital” (Angels, 2022). In contrast, the right stroke hospital functions efficiently as a team-based stroke system with quality and evidence-based processes (Mocco et al., 2015). The American Heart/Stroke Association (AHA/ASA) has led a national stroke coalition to ensure stroke victims have access to the proper care at the most appropriate hospital with strong ties and collaborations with EMS agencies. In fact, the Los Angeles County EMS agency has improved stroke outcomes by expanding and ensuring rapid access to MT in a two-tiered routing regional stroke system (Bosson et al., 2020).

Problem

Although the EMS two-tiered routing system has effectively expanded access to life saving MT stroke treatment to the majority of the ten million county residents, the northern most region of the county remained underserved due to the lack of thrombectomy-capable stroke hospitals (Bosson et al., 2020). People who had strokes in those areas were taken to the nearest non-advanced stroke hospital, and if an LVO were identified, they were transported by private air to an advanced stroke center far outside their communities. Most of the time, it was too late to perform a MT because so much time had passed, resulting in the stroke completion and long-term disability or death.

This community hospital is a level II trauma center servicing the northern area of the San Fernando Valley and the northern most regions of the county. Historically, the extent of stroke care was iv tPA administration with advanced imaging and critical care transport to a thrombectomy-capable center when an LVO was detected. Given the clinical practice guideline updates, EMS routing initiatives, and the community need, the hospital administration committed to advancing the stroke program and onboarded the appropriate clinicians to do thrombectomies 24/7 onsite. Though the specialty service was staffed, there were no team-based coordinated processes. Without a coordinated workflow, the hospital stroke program's reported quality performance metrics suffered, and did not meet the performance/quality criteria for EMS routing of complex strokes.

This DNP project is summarized by population (P), intervention (I), comparison (C), and outcome (O), 'PICO' mnemonic. The acute code stroke multidisciplinary response teams (P) will integrate an evidence-based optimized workflow into their practice (I). To ensure quality care and treatment delivery, standard advanced-stroke performance and quality metrics will be tracked and monitored pre and post-implementation (C). Improved quality performance outcomes will be measured by door-to-medical doctor (MD), door-to-Cat Scan (CT), door-to-tPA, door-to-puncture, and door-to-device per recommended standard measures that are stated in stroke clinical practice guidelines (CPGs) and the local county EMS standards for designation for routing of complex stroke patients (O).

Purpose Statement

The aim of this doctoral project is to bridge the gap in the emergency stroke practice by implementing an evidence-based optimized code stroke response system, befitting to the community hospital clinical setting, for greater efficiency of stroke intervention and enhanced quality performance and outcomes to meet the needs of the community.

Framework

Framework Background

Healthcare practices based on evidence advance clinical effectiveness through enhanced clinical decision-making and result in better patient outcomes (Lehane et al., 2018). The publication *To Err is Human: Building a Safer Health System* brought about a new awareness that humans naturally make mistakes and began the principle of strengthening systems to reduce medical errors (Kohn et al., 2000). Then, in 2001, *Crossing the Quality Chasm* published the blueprint for delivering quality healthcare with an underpinning of evidence-based practice (Baker, 2001). Both publications triggered a national shift to systematic quality improvement in healthcare delivery (Stevens, 2019). Then, in 2011, the Institute of Medicine published two reports, *Finding What Works in Health Care: Standards for Systematic Reviews* (Eden et al., 2011) and *Clinical Practice Guidelines We Can Trust* (Graham et al., 2011), which continued to define the essence of evidence-based practice (EBP).

Evidence-based practice is a shared responsibility across all healthcare disciplines, although, it is the basal diligence of the DNP to integrate EBP into the system (Stevens, 2013). Sometimes the DNP may be challenged to shift cultures to integrate EBP. A supporting framework guides the DNP change agent. Applying a suitable framework strengthens the overall level of excellence in practice by easing the way of the evidence to the patient. Although this

DNP project focuses on implementing an evidence-based multi-departmental stroke workflow protocol for efficient treatment, there is an unequivocal necessity to shift the culture in the ED. Hospital administration on-boarded the clinical experts to perform advanced stroke care procedures such as MT 24/7. However, the ED staff was not fully informed or prepared for the new directive which meant tremendous change.

The most applicable supportive framework model to this DNP project was the STAR Model of Knowledge Transformation which Dr. Kathleen Stevens developed in 2004 at the University of Texas Health Science Center at San Antonio (UTHSCSA). Dr. Stevens has pioneered EBP with a deep appreciation for research and created the STAR Model to close the gap between the literature and the patient (Stevens, 2019). The process of the STAR Model framework empowers clinicians with the evidence and the knowledge for an integrative EBP. The five points of the STAR Model represent the most essential stages of adaptation of high-quality research: (1) discovery research, (2) evidence summary, (3) translation to guidelines, (4) practice integration, and (5) process and outcome evaluation (Stevens, 2019). The continuous cycle depicts the organic flow of integrating fresh evidence into practice (Appendix A) (UTHSCSA, 2015).

Applicability

There was a significant knowledge gap due to the lack of preparedness for the advanced stroke services. The framework, yet simple in appearance, is deeply rooted in EBP and essential to systematic review and CPGs (Stevens, 2019). The STAR Model framework has successfully guided innovative methods for training and empowering nurses with EBP for integration into practice (Farra et al., 2015; Saunders et al., 2016). Though the STAR Model framework provides step-by-step guidance, the project and application of the framework required subject matter expertise and careful DNP leadership oversight.

This DNP project presents at a good time in the literature since multiple groundbreaking international randomized controlled trials (RCTs) published in 2015 produced a ripple effect of continued research and updated stroke CPGs for MT. There are national and local multidisciplinary networks and groups focused on improving outcomes associated with stroke where fresh knowledge and Best Practices are shared. However, the ED staff had not been introduced. They were uniformed and unprepared to facilitate a smooth throughput process to MT. At baseline, the ED staff was uncomfortable and conflicted with the directive to advance a comprehensive stroke program at their community hospital.

STAR Model Point 1: Discovery Research

The first step of knowledge transformation is discovering and collecting the relevant literature (Stevens, 2019). The AHA/ASA has done much of this work in their collection of stroke specific CPGs, scientific statements, policy statements, and systematic reviews. Additionally, shared experiences and protocols from regional community hospitals provide relevance to this DNP project. Considering shared experiences with lessons learned is critical to identifying gaps in the literature when integrating EBP (Stevens, 2019).

STAR Model Point 2: Evidence Summary

In the second step, the evidence is synthesized or summarized in a sensible, organized format (Stevens, 2019). At a very high level, this process has been stabilized by the AHA/ASA in systematic reviews and CPGs. However, a variety of evidence is essential for integration of knowledge, especially in the community hospital setting. The evidence supporting the literature are typically conducted at academic centers with robust quality stroke and research resources.

Therefore, summarizing the evidence in ways that meet the needs of the community hospital staff is critical.

STAR Model Point 3: Translation to Guidelines

The third point of the STAR Model framework is where the evidence or guidelines are translated into clinical practice. Thoughtful translation is critical since the clinicians changing their practice are not expected to be fully informed of all the evidence. In this DNP project, translation and delivery methods of the evidence were highly considered from the ED staffs' perspective. Focusing on the profound clinical outcomes and benefits published in the literature and real-life clinical outcomes shared by regional hospitals certainly helped to shift the culture (Stevens, 2019).

STAR Model Point 4: Practice Integration

Point four of the STAR Model is where the bounty of the literature pays off directly to the patient through enhanced clinical decisions that are evidence-based and result in high-quality care outcomes. This is also the point where the culture begins to shift. The integration into practice requires significant time, consideration, and stakeholder buy-in. Interprofessional collaboration underpins a successful practice integration (Stevens, 2019).

STAR Model Point 5: Process and Outcome Evaluation

The fifth point of the STAR Model is the evaluation of process-change outcomes stage and the last step before recycling through the framework with new knowledge. Interdisciplinary stroke team meetings are essential to review and discuss any deviations from the process, performance and outcome data, and any other feedback to assure quality. Any process deviations should not be punitive, rather encouraged for optimal learning. By this point, the project stakeholders should be able to reflect and feel a sense of fulfillment from meaningful practice change (Stevens, 2019).

Review of Literature

Although stroke has historically been calamitous globally, medical advancements have shifted that trajectory of negative impacts when and where available. The efficacy of the MT intervention in AIS is profound and has been ratified as the standard of care for treating LVO strokes. Research continues, and CPGs update to expand access to quality MT intervention. The recommendations provide evidence-based diagnosis and treatment standards and are rightfully broad for generalizability (Basker et al., 2020). This literature review was necessary to identify the most robust and applicable evidence to support an optimized emergency advanced code stroke workflow. This chapter will share the search strategy that was conducted and then transition to the major themes that surfaced.

Search Strategy

A literature search was initially conducted using the CINAHL, PubMed, and Google Scholar databases. The AHA/ASA guidelines and statements database was also utilized. Evidence of the efficacy of MT, optimal performance indicators, workflow and processes, outcomes, and CPGs were of most interest. The search terms applied included “acute ischemic stroke”, “mechanical thrombectomy”, “time”, “clinical outcomes”, “workflow process”, and “emergency protocol”. The search limitations were peer-reviewed, clinical trial, meta-analysis, RCT, review, systematic review, English language, from 2018- 2022, and NOT prevention.

Further article selection was done by backward citation chaining of the AHA/ASA Clinical Practice “Guidelines for the Early Management of Patients with Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines” (Powers et al., 2019) and the “Care of the Patient With Acute Ischemic Stroke (Prehospital and Acute Phase of Care): Update to the 2009 Comprehensive Nursing Care Scientific Statement” (Ashcraft et al., 2021). Citation chaining from empirical evidence helped narrow the scope of this DNP project. Articles that primarily investigated pediatric strokes, hemorrhagic stroke, pharmaceutical thrombolytic intervention, post-MT processes, and prevention were immediately excluded. Additional articles were excluded that investigated the more complex pathophysiologic details of ischemic stroke and those that challenged magnetic resonance imaging vs. computed tomography (CT) scans, given the level of accessibility at the community hospital. The PubMed and CINAHL database searches are outlined in Tables B1 and B2.

Review of Literature Background

Stroke negatively affects the victims, families, communities, and local and federal economy. Each year in the U.S., more than 795,000 people suffer a stroke, and about 610,000 are first-time events (CDC, 2022). AIS is a blocked cerebral artery that accounts for 87% of all stroke types, hemorrhagic vs. ischemic (CDC, 2022; Rennert et al., 2019). LVO strokes account for upwards of 50% of ischemic strokes and occur when one of the major proximal cerebral arteries becomes blocked, preventing the flow of oxygenated blood to large territories of the brain tissue (Rennert et al., 2019). Hypoxic brain tissue immediately becomes injured and ischemic. The tissue located at the center of the injury is the first to infarct, referred to as the core. The brain tissue surrounding the core is injured and will likely infarct if the perfusion of oxygenated blood is not restored. The injured tissue is called the penumbra and is the target area for saving the brain (Ayeode et al., 2019; Powers et al., 2019).

Treating AIS aims to restore cerebral arterial blood flow to the salvageable brain tissue, penumbra, before irreversible injury leads to death or long-term disability (Basker et al., 2021). The sooner the vessel can be opened, the less brain tissue is affected. Although intravenous tissue plasminogen activator (tPA) was the first standard of care for treating AIS, LVOs are commonly refractory to the thrombolytic drug (Albers et al., 2018; Rennert et al., 2019; Nogueira et al., 2018). MT is a non-pharmacologic, minimally invasive intervention where a specialty-trained physician guides a catheter, under fluoroscopy, to the clot within the cerebral artery. A tiny tool is deployed from the tip of the catheter and retrieves the clot, recanalizing the artery and restoring the perfusion of oxygenated blood (Mathews & De Jesus, 2023).

The year 2015 initiated the era of stroke reperfusion when five landmark international RCTs were stopped early due to the overwhelming efficacy of the MT intervention (Berkhemer et al., 2015; Campbell et al., 2015; Goyal et al., 2015; Jovin et al., 2015; Saver et al., 2015). This triggered a revolution in stroke care with countless research and significant updates to national and global stroke CPGs. A simple statistical concept to interpret the benefit of modern medicine is called the "Number-Needed-to-Treat" (NNT). The NNT translates to the number of subjects that must be treated to have a favorable outcome (The NNT, 2017). MT of an LVO has a NNT of 2 patients for one better disability score at 90 days, and 2.8 patients for one functionally independent at 90 days (Nogueira et al., 2018). The continued research has been aimed at expanding access, optimizing processes, and inculcating quality data reporting.

Time

Treatment eligibility has shifted from an assessment of time to the assessment of individualized patients. The earlier evidence considered patients with an LVO as identified on computed tomography angiography (CTA) for MT when the intervention could start within six hours from symptom onset (Berkhemer et al., 2015; Campbell et al., 2015; Goyal et al., 2015; Jovin et al., 2015; Saver et al., 2015). The CTA will show clinicians the LVO but will not show the brain tissue's response, such as the core and penumbra; therefore, clinicians conservatively assumed that LVOs completed core growth very quickly.

In 2018, two additional landmark RCTs discovered that LVOs evolved over more extended periods based on quantified perfusion imaging mismatch maps (Albers et al., 2018; Nogueria et al., 2018). Utilizing automated software for processing perfusion imaging from CT enabled nearly instantaneous visual mismatch maps of the patient's brain with color-coded overlays and numeric measurements of the core and penumbra, allowing clinicians to make informed, individualized treatment decisions. These results changed the standard of care to consider patients who present to the hospital for MT up to 24 hours from stroke symptom onset or unknown time of onset (Adeoye et al., 2019; Ashcraft et al., 2021; Pierot et al., 2018; Powers et al., 2019). Additional research attempting to correlate positive outcomes with patient subgroups fell short of the efficacy of perfusion imaging mismatch maps as the gold standard for patient selection. In the presence of sufficient salvageable penumbra, MT should be offered regardless of patient age, stroke severity, or even onset time to achieve optimal outcomes (Lansberg et al., 2019).

Although MT decision-making no longer relies solely on time, that does not mitigate the natural core growth process in the presence of an LVO. Time to reperfusion is the primary determinant of positive patient outcomes. Expedited time to MT treatment with reperfusion of sufficient penumbra reduces infarct growth and residual disabilities with improved functional independence at 90 days (Baskar et al., 2020; Bourcier et al., 2019; Kaesmacher et al., 2020; Maas et al., 2022; Yang et al., 2022). It is estimated that with each minute during a stroke, 1.9 million neurons die, and 4.2 days of healthy life are lost (Baskar et al., 2020). An optimized coordinated workflow is the most effective way to ensure timely MT intervention (Baskar et al., 2020; Bulwa & Chen, 2021; Yang et al., 2022; Zhang et al., 2021).

Coordinated Processes

The essential requisite of coordinated system-based processes to achieve quality performance and outcomes is echoed throughout the literature. The empirical evidence of the efficacy of MT was conducted in academic comprehensive stroke centers with robust dedicated resources and rigorous quality oversight of standardized processes, which may challenge applicability in the community hospital environment and was called out as a limitation (Albers et al., 2018; Campbell et al., 2015; Fransen et al., 2016; Saver et al., 2015). Given the landscape and community needs, suggesting that only academic centers offer MT is unrealistic. Given the evidence of the profound benefits of MT, many healthcare systems are remodeling to ensure coordinated best practices in a timely manner (Baskar et al., 2020; Bulwa & Chen, 2021; Wang et al., 2017; Yang et al., 2022).

Stroke system-based processes begin prehospital, are exhaustive in the ED and follow the patient and family through the entire stroke continuum (Adeoye et al., 2019; Jauch et al., 2021). Advanced practice nurses are primarily responsible for transforming the data from high-volume center trials to real-world experience (Adeoye et al., 2019; Baskar et al., 2020; Bulwa & Chen, 2021). The ideal optimized stroke workflow enhances interdisciplinary communication and fast responses for the most efficient diagnosis and throughput to the prepared neuro-interventional angiography suite for MT (Adeoye et al., 2019; Baskar et al., 2020; Yang et al., 2022). The methodology for sustainable, optimized MT workflow implementation is transparent quality performance and outcome data reporting and benchmarking (Adeoye et al., 2019; Ashcraft et al., 2021; Pierot et al., 2018; Powers et al., 2019).

Evidence-based Quality Data and Benchmarking

Data management and reporting are essential to every quality improvement effort. Internal stroke program quality process performance and outcome reporting allow the clinical teams to reflect on their practice for continuous improvement and care validation (Stevens, 2013). Transparent process and data sharing with regional stroke centers allow sharing of best practices and the continued drive to improve stroke outcomes for the communities served (Adeoye et al., 2019). The AHA/ASA's Get With The Guidelines (GWTG) is the standardized national stroke database that promotes consistent adherence to current evidence-based guidelines and metrics while accumulating extensive data for continuous quality improvement (Adeoye et al., 2019; Jauch et al., 2021). Additionally, GWTG strategically enhances staff morale and executive leadership interest through a publicly reported quality awards program.

Evidence-Based Guidelines

Given the wealth of evidence, quality MT stroke care guidelines are standardized and adopted globally (Pierot et al., 2018). Stroke CPGs provide the highest evidence-based guidelines and recommendations. Considering the profound impact of coordinated expedited stroke patient care, the guidelines endorse stroke program certification by an accrediting body (Adoeye et al., 2019; Baskar et al., 2020; Bulwa & Chen, 2021; Jauch et al., 2021). The stroke program certifying agency enhances best practices by critically reviewing emergency protocols, reviewing hospital processes, performance, and outcome measures, ultimately holding the hospital accountable to evidence-based standards (Bulwa & Chen, 2021; Jauch et al., 2021).

Summary

The literature review highlighted some of the highest evidence supporting the efficacy of MT with the highly efficient clinical processes underpinning. MT is unavailable at every hospital, and there remains a substantial disparity in timely quality access (Sarraj et al., 2020; Kamel et al., 2021). Hospitals offering MT to their community are obligated to establish robust systems-based care delivery and transparent performance outcome reporting (Adeoye et al., 2019; Bulwa & Chen, 2021; Powers et al., 2019). Although the evidence is substantial, the guidelines are standard, and hospital certification bolsters compliance; there remains a considerable gap in the community hospital environment. Special considerations should be made when advancing the stroke program at the community hospital where resources vary greatly compared to the academic medical centers where the evidence comes from. The aim of this DNP project is to bridge the gap in advanced stroke practice by establishing an evidence-based, multi-disciplinary, emergency workflow protocol that is befitting to the community hospital clinical environment. The optimized workflow should enhance multi-disciplinary communication for the most efficient triage and throughput to the prepared neuro-intervention angio-suite for MT to reduce morbidity and mortality associated with LVO stroke.

Methods

This DNP project aimed to improve advanced stroke clinical performance by implementing an evidence-based protocol workflow for suspected stroke victims who present to the ED. The evidence is abundant that faster reperfusion results in better outcomes and can be achieved when hospital-based systems are optimized for more efficient clinical workflows. The STAR Model was the most appropriate framework to streamline the integration of the evidence into practice at this community hospital. The five points of the STAR Model represent the steps of this DNP project plan: (1) discovery research, (2) evidence summary, (3) translation to guidelines, (4) practice integration, and (5) process and outcome evaluation (Stevens, 2019).

Design

This quality improvement project implemented an optimized, evidence-based, multi-departmental workflow process. The project lead developed the workflow protocol using standard performance time interval recommendations, standardized benchmarking performance goals, and shared experiences from high-performing regional stroke programs. The project setting logistics of the community hospital were extensively considered when creating the workflow from the evidence because of the difference in resources compared to academic centers. The key performance metrics were collected, analyzed, and compared for three months before and after the protocol implementation.

Setting

This DNP project was implemented at a 377-bed community hospital in Southern California. Historically, the extent of stroke treatment offered at this hospital was IV tPA and an interfacility transfer to a regional hospital for MT if identified. Recently, a group of neuro-interventional physicians was on-serviced and available to treat emergent MT 24/7. The hospital's catchment area for stroke was extensive due to the lack of any other MT-capable hospital within its radius. Over three million people lived in these communities without direct access to advanced stroke care. There was an irrefutable community need.

In recent years, the county EMS agency implemented a two-tiered routing system for LVO stroke, per practice guideline recommendations (Bosson et al., 2020). The county EMS agency systematized a robust designation process and only routed highly suspicious LVO strokes from the field to MT-capable hospitals that reported high-quality clinical performance and outcomes and were within a 30-minute transport time. The EMS agency was informed of this community hospital's efforts and was keen to expand access across the county.

The targeted population for this DNP project was the ED staff who respond to code strokes and perform standard-of-care tasks for optimal decision-making and treatment options. Those front-line staff included the ED nurses, physicians, and technicians, with hyper-focused nurse training as they were identified as the code leaders. Other departments' staff, such as the radiology in CT and the neuro-interventional angiography suite teams, were involved and always informed as critical stakeholders in an efficient throughput process.

Ethical Considerations

An Institutional Review Board (IRB) exemption approval from the university and the organization was obtained before implementing the DNP project. Refer to Appendix D for the project information sheet shared more broadly throughout the clinical program. Refer to Appendix E for the in-person script to inform the ED staff during shift-change huddles. Appendix F contains the workflow tool, which was used as the training tool for the ED staff and posted throughout the unit. The IRBs approved all three deliverables and determined the project exempt from research. The IRB letter can be found in Appendix H.

This DNP project posed little to no risk to patient safety or privacy. Fast and efficient system-based stroke processes to the angiography suite for MT reduce mortality, morbidity, and costs. The optimized process precludes ethical concerns because the baseline process was inefficient and reflected poorly on quality performance and clinical outcomes. All data collected contained absolutely no personally identifiable information.

Procedure

The STAR Model was applied to integrate the evidence into the streamlined workflow for greater adoption. The existing workflow should be considered as the baseline (Appendix C). Although all the significant steps were included, the workflow needed to be more streamlined. There was a lack of coordination, communication, and patient throughput. The workflow was logistically cumbersome for the frontline staff and caused significant delays in iv tPA and MT interventions that were problematic to clinical outcomes.

STAR Model Point 1: Discovery Research

The first step of the STAR Model includes gathering the most relevant evidence (Stevens, 2019), which was conducted per the literature review. Multiple large-scale international RCTs, CPGs, policy statements, systematic reviews, and peer-reviewed MT workflow quality improvement publications contributed to the significance of optimizing the code stroke response system for greater efficiency.

STAR Model Point 2: Evidence Summary

In this second step, the project leader synthesized the evidence in a way that translated well to the staff who needed to adjust their practice. The evidence of profound benefit when efficient stroke systems rapidly treat LVO strokes with MT was significant (Baskar et al., 2020; Bulwa & Chen, 2021; Wang et al., 2017; Yang et al., 2022). The AHA/ASA Target Stroke Phase

III (2019) provided clinical practice performance time interval goals for benchmarking and quality improvement efforts. The project leader designed the code stroke pit stop protocol workflow (Appendix F) based on the literature review, shared experiences from other regional hospitals, and clinical experience. This workflow was this project's interpretation of the evidence for the frontline staff to integrate into their practice.

STAR Model Point 3: Translation into Practice

The third STAR Model point was where the project lead transformed the evidence and highly evident recommendations to the clinical practice by implementing an optimized workflow. The following steps were taken for this project:

1. Development of the project participant correspondence and summary in alignment with ethical considerations (Appendix B).

2. Design the code stroke pit stop workflow map with an informational one-sheeter training tool for the clinical staff participants' practice integration (Appendix F).

Code Stroke Pit Stop Methodology Procedure. The baseline emergency code stroke process was inefficient, causing interdisciplinary confusion and delays in throughput to MT. The delays appeared to be caused upfront when all suspected stroke patients were roomed in potentially any room, and the technician, nurse(s), and physician would respond in tandem before the code stroke was activated, prompting CT for the standard-of-care imaging required for treatment decision making. Roles, flow, and expectations were not clear.

The optimized code stroke pit stop process consolidated all standard-of-care stroke triage and assessments, both in clinical function and location within the department. All stroke victims who arrive at the ED by EMS or walk-in are taken directly to the pit stop in the ED hallway just inside the ambulance bay entrance to the unit. The pit stop station was newly designated and maintained with a dedicated weighted gurney and all required tools for acute stroke triage within reach, such as a glucometer, vital sign machine, and intravenous insertion kits. When the patient is brought to the code stroke pit stop, a unit-based overhead page activates the stroke pit stop team, which includes an ED physician, the ED quality/stroke nurse, two ED staff nurses, and an ED technician.

The optimized workflow tool provided explicit response teams' roles and responsibilities to be carried out in parallel, much like the pit stop crews in motorsports (Appendix F). The ED physician performs a quick safety assessment, ensuring the patient's airway is intact, they are breathing, and they have a pulse. Then, a very brief neurological assessment is performed to confirm the suspicion of stroke. One ED staff nurse ensures a patent intravenous port, draws blood for preliminary labs, and performs a point-of-care blood glucose test. The second ED staff nurse receives a report from paramedics or family, collects health information, including presenting symptoms and medication list, and then charts in the electronic health record (EHR). The ED technician connects the mobile vital sign machine to the patient, captures a set of vital signs, cycles the blood pressure to monitor every 15 minutes, and announces the first readings to the pit stop crew for awareness. The ED quality/stroke nurse responds to all code strokes at the pit stop to shepherd the process and is the central point of contact for each stroke, armed with resources, direct lines to the various stroke departments and physician leaders, and a mobile phone.

Beyond the pit stop, the ED staff nurse manages direct patient care throughout the process or until handoff. The ED technician provides support during the pit stop, in transport to and from CT, and as needed. The ED medical staff implemented a standard order set with expedited stroke imaging orders to ensure the experts make optimal treatment decisions.

Streamlining patient-centered communication was another significant improvement to the process. The ED quality/stroke nurse assumed the role of the code leader. The ED quality/stroke nurses received augmented stroke education and training primarily from the MT physician leaders. They were expected to respond to every code stroke pit stop, not to provide patient care, but instead manage communication across departments to ensure safe, smooth throughput to advanced treatment. While in the pit stop, the ED quality/stroke nurse calls the on-call MT physician with highly suspicious LVOs even before CT. This task saves time by notifying the MT treatment decision makers much sooner in the process. The ED quality/stroke nurse maintains an open line with the MT physician for real-time treatment decisions and patient throughput readiness. Once the MT physician confirms the LVO from diagnostic CT images, they can activate their angiography interventional suite team. The team has a 30-minute response requisite per hospital policy; however, compliance needs to be regularly monitored, and realistic determinants so often challenge the on-call teams. The baseline code stroke process reflected a delayed MT physician notification of LVOs, hindering optimal performance and clinical outcomes.

Overall, the optimized workflow protocol consolidated the standard of care tasks, clarified roles and responsibilities, and informed the staff of expectations and goals. The additional layer of patient-centered communication, managed by a single role within the hectic ED environment, enhances overall efficiency and quality.

The Goals. To ensure clarity of expectations and to enhance engagement and adoption, the workflow map was designed and outlined with three types of goals: functional, project, and standardized global.

The functional goals are unit-based and provide a goal for the time spent in each transition phase of the patient throughput. These goals were strategically planned for highly efficient processes utilizing standard recommendations, considering the 30-minute response time by the angiography interventional team per policy, and meeting the standard benchmark performance measures. The functional goals were also used to provide performance feedback to staff.

The three project goals, door-to-CT start ≤10 minutes, CT start-to-groin puncture ≤60 minutes, and puncture-to-device ≤20 minutes, are evidence-based benchmarked quality performance metrics (AHA/ASA, 2019). These project goals are incremental to the standardized global goal and thus should hone delays or inefficiencies within a smaller group to better target improvement.

The AHA/ASA Target Stroke Phase III (2019) provided targeted time goal intervals for performance measures to accomplish the widely adopted Door-To-Device (DTD) goal of ≤90 minutes. The DTD goal of 90 minutes is the global standard quality performance measure used by AHA/ASA for hospital quality awards and by the county's EMS agency for monitoring hospital quality assurance per the two-tiered routing designation standards. Although a DTD of 90 minutes is considered the standard performance outcome measure for thrombectomy programs, this DNP project was driven by the incremental performance measures leading up to the final "device" time.

Gaining Stakeholder Buy-in. Given the necessary culture shift, exceptional attention to gaining stakeholder buy-in was critical. Execute sponsorship of this doctoral project was necessary to influence such change. The project leader facilitated executive-level directive report-out to all department leadership. Executive leadership announced via the intranet that the hospital was excited to start providing MT services to the community. Also, executive team members showed their support by periodically attending staff huddles and sharing the vision of expanding MT services to the community. Although the target staff of this DNP project did not report directly to the executive leadership team, they admired and respected them tremendously. The executive team empowered this DNP project with their influence.

Gaining the ED nurse leadership teams' buy-in was most notable. The ED nurse leadership team included the unit manager, assistant managers, and educators. This team historically owned all the unit-based processes, including stroke, and was initially opposed to modifying the code stroke process to advance the MT stroke program. The project leader strategically coordinated activities to gain their buy-in, such as conducting mock code stroke drills. The mock code stroke drills exercised the process within the ED. The nursing leadership team was invited to participate as the mock patient and family member, which put them in the perfect position to observe firsthand the inefficiencies of the old workflow and the opportunities for improvement as suggested by the evidence and within the new workflow. Gaining this team's buy-in was pivotal for the overall adoption of the new pit stop.

Finally, all ED quality/stroke nurses were crucial stakeholders, and their buy-in was essential. They had to believe in the process change to support it to the extent they were expected. The ED staff nurses were also stakeholders whose buy-in was necessary. The project leader enhanced ED nursing staff engagement by earning trust through transparent collaborations and frequent *Gemba* walks.

STAR Model Point 4: Practice Integration

Point four of the STAR Model is where evidence-based change occurs. Methods for ensuring a smooth integration were vital to the success of this DNP project.

Smooth Integration. Empowered stakeholders facilitated the integration of the evidence into practice (Lowther et al., 2021). The MT physician director implemented a multidisciplinary stroke action-driven workgroup to develop the advanced stroke program. The workgroup met every two weeks and included all the critical stakeholders for this DNP project. The project leader leveraged the workgroup meeting to inform, collaborate, and implement the code stroke pit stop workflow. The workgroup meeting was a place to review real-time quality and performance data, revisit the process, hear feedback from frontline staff, make recommendations, make revisions, and plan for training and complete adoption.

Given the acute nature of code stroke response systems and the large number of ED staff nurses, training in the new workflow required a train-the-trainer approach. The ED quality/stroke nurses were identified as the project champions. They were included in the workgroup meetings, presented with the evidence, contributed to the workflow design, and participated in all mock code stroke drills for better practice. Also, mock code stroke drills were excellent experiential learning opportunities for the ED nurses staffed at the time. However, the ED staff nurses were trained in the new workflow during shift-change huddles. The project leader trained the ED quality/stroke nurses to effectively train the staff by reviewing the training tool (Appendix F) at the pit stop station during every shift-change huddle to ensure every ED nurse was informed. The ED quality/stroke nurse role was an integral stakeholder that fostered widespread informed adoption and promoted sustainability. This subgroup of ED staff nurses received additional stroke training, primarily from the MT physicians, and was prepared by the project leader to facilitate the integration of the code stroke pit stop workflow. The ED quality/stroke nurses supported a smooth integration by being fully engaged, contributing to the design, informing staff, providing real-time education, and collating staff feedback for reporting and follow-up.

The role was indispensable because the project leader could attend some shift-change huddles to train the ED staff nurses. Overall, the role of the ED quality/stroke nurse led the emergent clinical process, navigated patient throughput, and managed communication among a variety of acute care teams according to the workflow map (Appendix F) and could quickly adapt to changing emergency priorities that may divert from the protocol.

Tools and deliverables for this DNP project were marked to support a smooth integration. The code stroke pit stop workflow was printed on single-color paper and laminated. The laminated flow maps were disseminated by the project leader or ED quality/stroke nurse during shift change huddles, posted at the stroke pit stop, in the ED nursing station, in the physicians' dictation room, on the ED quality/ stroke nurses' clipboard, in CT, and in the angiography suites where MT is conducted. The color coding assisted with managing consistency. If changes were made to the workflow, all existing flow maps were pulled and replaced with the update on a different colored paper. This prevented confusion among staff by lingering old workflows.

Finally, the practice of the new pit stop supported clinical adoption and integration. Mock code stroke drills were conducted periodically throughout the project to ensure a smooth integration into practice. The nature of the code stroke process is critically emergent. The first mock code stroke drill was instrumental in the ED nursing leadership's acceptance of the need for change in practice and implementation of the pit stop. Following the first, the mock code stroke drills utilized the new pit stop station and team approach. These mock codes were scheduled during a low unit census. The ED staff was initially informed of a scheduled code stroke to ease the culture shift. However, as the staff became more comfortable, the drills were unannounced to help sharpen critical thinking skills and to maintain the heightened sense of urgency that exists in the hyperacute phase of stroke. Overall, the mock code stroke drills helped improve staff comfort and iron out unforeseen logistical issues.

STAR Model Point 5: Process and Outcome Evaluation

In this final step of the STAR Model, the project lead collated the clinical performance data and, in collaboration with the project committee chair, evaluated the outcomes of this DNP project.

Data Collection and Storage. The data collection drew upon this community hospital's standard GWTG data quality assurance process. The ASA/AHA's GWTG is a hospital-based quality improvement program designed to close the treatment gaps in cardiovascular and stroke care as the national stroke data registry. The local stroke coordinator manages an electronic log of all code stroke cases, including timestamps of critical quality and performance metrics within the hospital system's Research Electronic Data Capture (REDcap) database. Excel spreadsheets are exported periodically by the stroke coordinator to check and confirm accurate data abstraction into GWTG for reporting and benchmarking. The hospital system's REDcap is a highly secured database with multi-factor authentication sign-in, and the local stroke coordinator has access. For this DNP project, the stroke coordinator exported the Excel report filtered with the performance metrics of only de-identified code stroke cases. This data collection occurred on a hospital desktop computer located in a locked office onsite within the hospital's firewalls. The de-identified aggregated clinical performance data of the pre- and post-quality improvement implementation was sent via an encrypted email. The file, which is password-protected to enhance security, was then downloaded, and stored in a secure Dropbox location designated for this project.

Data collection occurred monthly for three months. The first data collection included three months of pre- and one month of post-implementation data. The second and third data collection included data from each of the following two months. There were 97 pre-implementation cases and 124 post-implementation cases (code strokes) included.

Performance Data. Although this DNP project was driven by quality systems-based efficiency for the MT procedure, the code stroke pit stop process is initiated for all suspected acute strokes to rule out stroke mimics and rule in the standard-of-care treatment iv tPA and/or MT. Additional metrics were included in the data to provide supplemental performance perspectives, given the limited MT volumes at the hospital.

The data points included in this DNP project are all standardly monitored metrics that measure the optimal performance of stroke care and treatment delivery and are measured by time. These different timestamps reflect the process starting with the time the patient arrives, to the first physician contact, to CT for diagnostic imaging, to iv tPA administration, to groin puncture, which is the start of the MT procedure, and finally to device time, which is when the MT device makes contact with the clot lodged in the major cerebral artery. In practice, these tasks occur consecutively; however, iv tPA and MT treatment decisions can only be made after diagnostic imaging by CT is reviewed to confirm findings. Additionally, given the immaturity of this stroke program, it was expected to over-activate code strokes, yielding many more door-to-MD and CT times to far less treated cases (iv tPA and/or MT).

Data Analysis Evaluation. In collaboration with the project committee chair, the project leader collated the data for review. The project leader compiled the data in control charts, including case data from three months pre- and three months post-implementation. Descriptive statistics with aggregated means for central tendency were used to analyze the project data. The data analysis aimed to evaluate how the new workflow affects response times and clinical outcomes in stroke intervention. This involved a detailed examination of performance and quality metrics in stroke care, measured by calculating their mean and standard deviation before and after implementing the new workflow. Additionally, the Independent Samples t-test was utilized to analyze changes in these metrics, focusing on how the timing of patient care has been affected by the new workflow.

Resources, Budget, and Time

Considering the limited resources commonly experienced in the community hospital setting, the project was designed conservatively and creatively. Making such logistical changes for the pit stop station required heightened awareness to ensure the right resources were always available in that space. The hospital's environmental services leadership was included and empowered by executive leadership to support the pit stop station, particularly maintenance of the dedicated weighted gurney. The ED staff was then responsible for stocking the station with needed equipment, like checking the unit's crash carts. The ED quality/stroke nurses were another vital resource to the project as they were the trainers. The resources needed by the ED quality/ stroke nurse role were primarily informational, such as the on-call schedules, lists of phone numbers, and other printable deliverables. The mobile phones were part of the existing resources available to the teams.

There was no budget for the project. All project work or training was done during work hours. Training was always done in the ED, never simulation. All roles identified to support this DNP project were existing. Therefore, no additional FTEs were requested. Deliverables were printed on hospital printers, and the executive assistant team provided plastic sleeves. The executive assistant team played an essential role in managing the communication of the executive directive.

The timeline of this DNP project began in October 2023 following IRB approval for exemption. Given the facility's directive, the new workflow's literature search, synthesis, and proposed design began early. The project proposal was defended to the university and included the aim, literature review, framework, methods, and proposed workflow map. After the defense proposal to the project committee leaders, the approval letter was obtained from the facility CEO, a prerequisite for IRB submission (Appendix I).

The planned data to drive this DNP project included standardized key performance metrics usually used for reporting and benchmarking. All data is de-identified of any personally identifiable information. Once the IRB approval for exemption was obtained, the project leader began the data collection for this project. A total of six months' worth of code stroke data was collected to analyze performance metrics three months before and after implementation of the code stroke pit stop.

Summary of Implementation Plan

The community's need for access to quality advanced stroke services was identified. A robust literature review was conducted, and the findings validated the need for quality improvement per this DNP project. The project plan proposal was thoughtfully developed using evidence from the literature combined with shared experienced evidence from other regional community hospitals. A formal proposal defense was conducted before submission and receipt of the IRB approval of the exemption. This quality improvement DNP project was implemented over three months. Special attention was paid to the shift in culture. Only de-identified standardized performance data consisting of three months pre- and three months post were collected and analyzed to measure the impact of this DNP project. Finally, the results were formulated, and the findings were disseminated at the facility and university.

Results

Descriptive Statistics: Participant Characteristics

This chapter presents the results of this DNP quality improvement project aimed at enhancing stroke care in the ED. The project involved the collaboration of an ED quality/stroke nurse and ED staff nurses, focusing on a cohort of 221 stroke patients divided into pre- and post-intervention groups, with 97 patients presenting before and 124 after the implementation of a new workflow. A total of 12 ED quality/stroke nurses and upwards of 60 ED staff nurses participated in this doctoral project. The improvement measures targeted critical care performance and quality metrics such as time to first MD contact, CT scan initiation, tPA administration, groin puncture, device usage, and NIHSS scores at arrival and discharge. This analysis seeks to evaluate the effectiveness of the new workflow in reducing response times and improving patient outcomes in stroke care.

Table G3 illustrates the impact of a new workflow on stroke care performance and quality metrics, comparing mean values and standard deviations before and after its implementation. There was a notable decrease in the time for the first MD contact, dropping from an average of 17.88 minutes pre-implementation to 11.44 minutes post-implementation. The time from door to CT start showed a marginal increase, from 30.16 to 30.94 minutes, suggesting minimal change with the new workflow. Considerable improvements were observed in the door-to-needle time, reducing from 80.25 minutes to 57.13 minutes, and door-to-groin puncture time, which halved from 124.00 minutes to 62.50 minutes. The door-to-device time saw a slight reduction from 157.00 minutes to 149.50 minutes. NIHSS improvement showed a minor change, from 1.84 to 1.54. These results suggest that the new workflow led to an enhancement in several critical aspects of stroke care, particularly in reducing treatment times and potentially improving patient outcomes.

Data Analysis

The Independent Samples t-test was used to examine how stroke care performance and quality metrics changed before and after introducing a new workflow, focusing on various time-related aspects of patient care delivery (Table G4). The results showed no statistically significant changes across most time intervals. However, there was a significant improvement in the time for initial physician contact after implementing the new stroke workflow ($t_{218.00} = 3.49$, $p < .001$). While not all improvements reached statistical significance, such as the reduction in time from door to groin puncture by an average of 61.50 minutes, these findings suggest areas where clinical practice might be enhanced to better patient outcomes. Despite the lack of statistical significance in some areas, these results are clinically meaningful and warrant further investigation. Further studies, possibly with larger sample sizes or using different methods, could help understand these trends better and apply them to improve clinical practices.

Discussion

The primary purpose of this DNP project was to implement an optimized stroke workflow protocol to improve clinical quality performance of care and treatment delivery to reduce morbidity and mortality associated with stroke in an acute care facility. There was a statistically significant mean difference in the time for the first MD contact compared to before and after the intervention, indicating greater efficiency in the hyperacute phase of the code stroke process. Surprisingly, the faster time to the first MD did not seem to affect the next measured step of the process, the time to CT for diagnostic imaging for treatment decision-making. In a separate code stroke quality improvement project that sought to improve the stroke program's performance of the door-to-tPA, similar care delivery process metrics were analyzed, and the door-to-first MD and the time-to-CT changes had less effect on improving door-tPA compared to faster decision to treat times; suggesting that streamlined communication to the treatment decision makers has the most significant impact on improving treatment times (Chiu et al., 2021). Although this DNP project data lacked enough treated cases (iv tPA and/or MT) to identify statistical significance, clinically significant differences were noted for both quality treatment performance metrics. Door-to-tPA administration improved by 23.13 minutes, and door-to-puncture improved by 61.50 minutes. These improvements in stroke treatment delivery met the EMS and accrediting agency's performance requirement standards for advanced stroke center certification and designation. The literature provides generalized recommendations for quality performance improvement in stroke to achieve highly efficient performance of stroke treatment delivery (AHA/ASA, 2019). However, this doctoral project provided insights into the adaptability in the community hospital setting. Further consideration is needed to identify meaningful timestamps and ensure reliable data collection.

One primary objective of this project was to bridge the stroke knowledge and practice gap among ED staff at this community hospital. Although data was not collected to measure this gap-fill, the STAR model, deeply rooted in EBP, facilitated a framework for this culture shift. Disparities exist in new knowledge integration and stroke quality improvement methodologies between community hospitals and academic centers (Lowther et al., 2021). The project leader successfully integrated new knowledge into the ED staff's clinical practice by transforming the evidence into the workflow protocol tool. Although this objective was not directly studied, given the abundant number of ED staff, undocumented feedback was positive regarding the design and execution of the optimized workflow. The ED staff reported that the protocol deliverable was easily applied in practice and reinforced the much-needed team approach to stroke care with clearly defined roles and responsibilities. In another nursing stroke process quality improvement for MT performance, which accomplished statistical significance in MT treatment and NIHSS outcomes, the authors discussed the underpinning of a nurse-driven multi-disciplinary pathway with clearly stated roles and responsibilities. Stroke patient outcomes are related to the emergency response process and degree of teamwork (Zhan et al., 2021).

Recommendations and Implications

This quality improvement doctoral project provides a shared experience of a community hospital advancing stroke services and certification. The evidence-based streamlined workflow was designed for optimal application and efficient patient throughput. It included clear roles and responsibilities, location flow of the patient, and performance targets aligned with CPGs. Though the workflow protocol included guidance for a highly efficient process, there was no standard method for capturing the data in the EHR. Given the project's focus on improving stroke care efficiency and documentation, it is recommended to incorporate specific data fields into the EHR that align with the redesigned stroke service workflow. These fields should be tailored to capture key performance metrics and patient flow details as the new workflow protocol specifies. Implementing these changes will enable the hospital staff to systematically track progress, assess the efficacy of the interventions, and ensure continuous quality improvement.

Implementing the pit stop station and team response was a pivotal change to the code stroke process. Though this method ensured highly efficient triage and early MT physician involvement, the initial suggestion of such change to the ED logistics stirred up a sense of cultural resistance. The opposition to this change was verbalized in the discussions and development of the protocol. Outcomes data from a regional community hospital implementing a similar process helped convince stakeholders. Moreover, enabling the ED nurse leadership team to witness firsthand, as the mock code stroke aphasic patient and family, how inefficient the baseline process functioned assisted in gaining their buy-in. They facilitated many mock code stroke drills in the pit stop to ensure their full support and a better sense of ownership. Additionally, this doctoral project identified the team of ED quality/stroke nurses as the quality improvement process champions in acute practice. Specialized stroke training, project development, and implementation responsibilities empowered this subset of ED nurses. In the community hospital stroke program with a single stroke coordinator, expecting full adoption of quality improvement practice changes may be unrealistic. Empowering core groups of nurses to champion stroke quality improvements leads to more meaningful change and, hence, a greater sense of accomplishment by the whole team. (Ashcraft et al., 2021). Because the primary role of the ED quality/stroke nurse was to manage patient-centered communication, the on-call MT physicians needed to be supportive of the learning curve and prepared for overcalling by the team. The MT physicians should follow up with case-specific education to close the gap.

The clinical workflow changes in this doctoral quality improvement project required executive leadership support for stakeholder buy-in, enhanced adoption, and overall sustainment. Lacking organizational support is reported as one of the most common and significant barriers to stroke quality improvement success (Lowther et al., 2021). Strategic efforts were made to leverage the executive leadership's influence and to assure widespread awareness of the executive directive to expand high-quality MT access to the underserved community. This included hospital-wide intranet announcements, a kick-off celebration for the MT program in the hospital front lobby, periodic presence in shift-change huddles discussing the optimized workflow, and an identified executive sponsor to the workgroup meetings. Other community hospitals seeking to advance quality stroke services should consider the community's needs and executive leadership's commitment and build quality improvement projects to make meaningful changes.

This DNP project sought to empower stakeholders by enhanced engagement and education. However, more significant opportunities to motivate the staff are needed to ensure the sustainability of quality improvement. Motivating care teams to embrace and sustain quality improvement through organizational incentives and rewards yields highly reliable outcome findings. Additionally, enhanced clinical outcomes feedback, including patient stories, motivates staff and reinforces self-efficacy (Lowther et al., 2021).

The findings of this DNP project underscore the importance of further investigation, suggesting that future research with larger sample sizes or different methodologies may be necessary to fully understand and leverage these observations for enhancing advanced stroke clinical processes, particularly in the community hospital setting.

Strengths and Limitations

One strength of this doctoral project was the degree of executive leadership support. This ensured more significant influence, stakeholder buy-in for big change ideas, and widespread adoption. Another strength of this doctoral project was the amount of evidence. The abundance of literature and robustness of the CPGs made the project design more consistent. A final strength was the staff's commitment to their stroke community. Once they understood how this could impact the outcomes of their community, they bought in.

One limitation of this doctoral project was the validity of the data. There were minimal numbers of treated cases (iv tPA and/or MT) during the data collection for this project, so the sample size needed to be larger. Additionally, the data entry by the nursing staff was inconsistent, and time constraints limited the effectiveness of this project. To improve consistency, it is recommended that the project integrates EHR with specific protocols for data entry that include retrieving timestamps directly from the EMR. This approach will ensure more accurate and consistent documentation.

Despite these challenges, the quality improvement doctoral project successfully implemented a code stroke pit stop, significantly enhancing process efficiency and multidisciplinary collaboration compared to the baseline. To build on this success, ongoing training sessions and periodic reviews should be incorporated, along with continuous monitoring and updating of EMR documentation practices to maintain and enhance the system's effectiveness.

This quality improvement project may have lacked rigor, given the project leader's inability to attend to acute code strokes. Code strokes present to the ED at all times day and night, crossing over every shift. Identifying the ED quality/stroke nurse as the project champion to shepherd the process in such an unpredictable environment supported the implementation of the optimized workflow. However, more rigor around tracking and monitoring the utilization of the practice change is needed to ensure the validity of the project outcomes and overall sustainability.

Conclusions

In summary, this quality improvement doctoral project implemented a code stroke pit stop that facilitated greater process efficiency and multidisciplinary collaboration compared to the baseline. The project design was in response to the local community need and practice guidelines and expanded access to advanced stroke care through highly efficient emergency response systems (Powers et al., 2019). Although the data collection was limited, there was a clinically significant improvement in the performance of standard-of-care stroke treatment delivery, door-to-tPA, and door-to-puncture treatment times, qualifying this community hospital stroke program for advanced stroke center certification and designation by EMS for routing complex strokes. This project can contribute to future innovative process changes to advance stroke response systems at community hospitals for improved efficiencies and overall quality care.

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Appendix A

The Stevens STAR Model of Knowledge Transformation

Appendix B

Review of Literature Databases Search Strategy

Table B1

Database: PubMed

Search Terms	Limits	Articles Retrieved	Articles Excluded	Articles Reviewed	Articles Used
Mechanical Thrombectomy AND Ischemic Stroke AND Time	Clinical Trial, Meta-Analysis, RCT, Review, Systematic Review, English language, date: 2018-2023	159	157	20	2
Acute Ischemic Stroke AND Mechanical Thrombectomy AND Clinical Outcomes AND Process	Clinical Trial, Meta-Analysis, RCT, Review, Systematic Review, English language, date: 2018-2023	17	16	10	1
Acute Ischemic Stroke AND Mechanical Thrombectomy AND Emergency Protocol	Clinical Trial, Meta-Analysis, RCT, Review, Systematic Review, English language, date: 2018-2023	11	11	10	0

Note. Articles excluded based on duplicates and relevance of the project.

Table B2

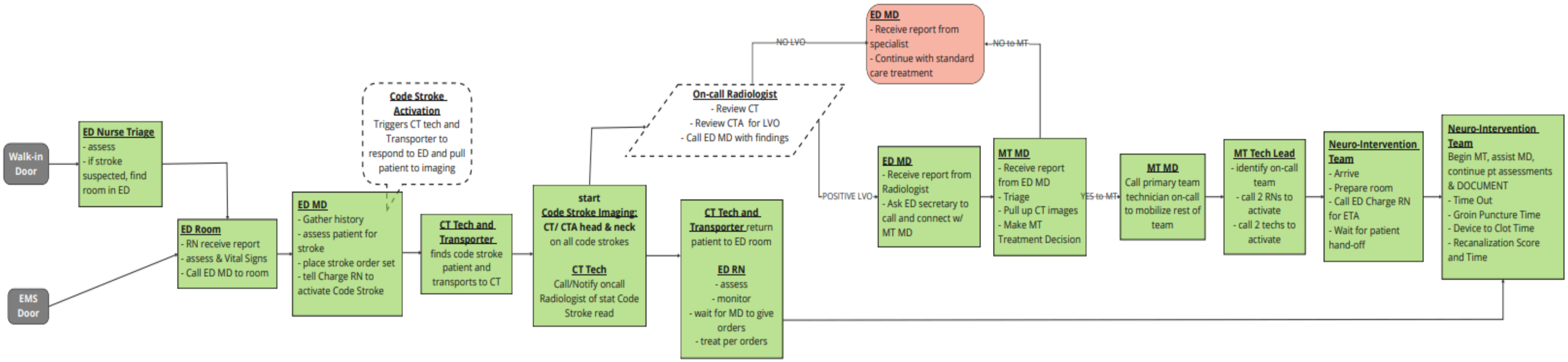
Database: Cumulative Index of Nursing and Allied Health Literature Search (CINAHL)

Search Terms	Limits	Articles Retrieved	Articles Excluded	Articles Reviewed	Articles Used
Mechanical Thrombectomy AND Ischemic Stroke AND Workflow	Peer reviewed, English language, date: 2018-2023	19	17	5	2
Acute Ischemic Stroke AND Workflow Process AND Patient Outcomes	Peer reviewed, English language, date: 2018-2023	8	7	4	1
Practice Guidelines AND Ischemic Stroke Treatment NOT Thrombolytic Therapy NOT Prevention	Peer reviewed, English language, date: 2018-2023	50	47	10	3

Note. Articles excluded based on duplicates and relevance of the project.

Appendix C

Figure 2: Baseline Code Stroke Workflow



Appendix D

Doctor of Nursing Practice (DNP) Project Summary

Doctor of Nursing Practice (DNP) Project Participant Agreement and Information Sheet

Project Title: The Implementation of the Code Stroke Pit Stop: A Quality Improvement Project for Greater Efficiency

Doctoral of Nursing Practice (DNP) Student: Helaine Kauffman, MSN, RN, SCRN

Providence (DNP) Mentor: Neha Mirchandani, MD, Stroke Medical Director

Faculty Team Leader: Ayman Tailakh, Ph.D., RN, Faculty Team Leader

Faculty Committee Member: Cinthya Vasquez Sotelo, DNP, FNP-C, ENP-C, Faculty Committee Member

Project Description: Efficient code stroke to mechanical thrombectomy (MT) processes are the underpinning to quality patient care outcomes for large-vessel occlusive (LVO) strokes. The purpose of this quality improvement doctoral project is to streamline the process by implementing an evidence-based workflow/protocol designed for highly efficient teamwork, enhanced communication, smooth throughput across numerous departments, and effectively patient centric.

The most significant update to the current state code stroke workflow is the implementation of the *pit stop*. The *pit stop* is a stocked location in Hallway 1 with a dedicated weighted gurney that does not leave for other use. All code strokes that present to the emergency department (ED) will be brought directly to the *pit stop*. The *pit stop* response team includes an ED Tech, 2 ED RNs, ED Quality RN, and an ED MD. In the *pit stop*, numerous emergency stroke standards are met including quick stroke assessment, patient weight for weight-based drugs, lab draws, and baseline vital signs. Roles and responsibilities of the code response team are clearly listed and should be conducted concomitantly, like the pit stop crews in Nascar. The on-call MT MD will be notified of suspected LVO strokes from the *pit stop* by the ED Quality RN. The sooner the MT MD is looped into the code, the better the treatment decisions and the sooner reperfusion can occur.

ED Quality RN's on shift during a code stroke will take the lead role in the code, manage patient-centric communication for safe and efficient treatment, and coordinate across multiple departments for smooth throughput to the angio-suite for mechanical thrombectomy, when appropriate. ED staff RN's who respond to the code stroke will maintain 1:1 complete patient care including treatment and monitoring per standard stroke protocols and physician orders until handoff is conducted. Neuro-intervention team RN's on shift during a code stroke will respond and arrive to the angio-suite asap (≤30 mins per policy), communicate availability, prepare room, and receive hand-off from ED RN and ED Quality RN.

Emergency department (ED) RN participants will be trained to the workflow/protocol during shift huddles for approximately one month. During the month dedicated to training, no performance data will be collected or used for this doctoral project. The *pit stop* location has been set up, stocked, and the ED admitting will begin overhead paging "code stroke *pit stop*" for the response teams. When "code stroke *pit stop*" is called overhead, you should respond to the *pit stop* in Hallway 1, armed with the attached workflow, and prepared to assume appropriate roles.

Standardized benchmark MT performance measures will be used. The primary outcome measure will be Door-To-Device ≤90 minutes which aligns with national and global standards. Maintaining Door-To-Device times ≤90 minutes is required to maintain hospital stroke certification, EMS routing designation, and to ensure quality patient outcomes. The secondary outcome measures Door-To-CT start ≤10 minutes, CT start-To-Groin Puncture ≤60 minutes, and Puncture-To-Device ≤20 minutes are the formula for Door-To-Device and are based on Best Practices applicable to this community hospital.

Confidentiality: Although the participants are ED staff RNs and ED Quality RNs, the study data has no direct association. No personally identifiable information (PII) of any kind will be obtained or included in this doctoral project. All performance data metrics will be recorded anonymously and reported as aggregate data.

Risks and Benefits: This project poses little to no risks as there will be no direct interaction with patients or their PII or PHI. The participating staff's performance data and feedback will also be anonymized; the primary focus is the process.

Questions: Contact information for Principal Investigator: Ayman Tailakh, Ph.D. RN, Email: Ayman.Tailak@calstatela.edu

THIS PROJECT HAS BEEN DETERMINED TO BE EXEMPT FROM REVIEW AND APPROVAL BY THE CALIFORNIA STATE UNIVERSITY, LOS ANGELES INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH.

Appendix E

In-person Training Script

In-Person Recruitment Script

PI/Co-PI: Good morning/afternoon/evening team, as the hospital advances in stroke care delivery and expands mechanical thrombectomy access to the community, optimization of the code stroke workflow is essential for quality patient care outcomes. A workflow/protocol was developed using the best evidence available and is an attached document.

Description of Project/Participant Role: As a participant, you will be asked to integrate evidence-based practices into your standard code stroke workflow by implementing an optimized protocol. The optimized workflow/protocol is designed for highly efficient teamwork, enhanced communication, and patient-centric care. The workflow/protocol is mapped out on the flow diagram and includes detailed roles, responsibilities, logistical and performance goal times. ED staff RN's who respond to the code stroke will maintain 1:1 complete patient care including treatment and monitoring per standard stroke protocols until handoff is conducted. ED Quality RN's on shift during a code stroke will take the lead role in the code, manage patient-centric communication for safe and efficient treatment, and coordinate across multiple departments for smooth throughput to the angio-suite for mechanical thrombectomy, when appropriate. Neuro-intervention team RN's on shift during a code stroke will respond and arrive to the angio-suite asap ($\leq$30 mins per policy), communicate availability, prepare room, and receive hand-off from ED RN and ED Quality RN.

Although the participants are ED and Neuro-intervention RNs, the study data has no direct association to you. Absolutely no personally identifiable information (PII) will be obtained or included in this doctoral project. Standardized benchmark mechanical thrombectomy performance measures will be used for this doctoral project.

The primary outcome measure will be Door-To-Device $\leq$90 minutes which aligns with national and global standards. Maintaining Door-To-Device times $\leq$90 minutes is required to maintain hospital stroke certification, EMS routing designation, and to ensure quality patient outcomes. The secondary outcome measures Door-To-CT start $\leq$10 minutes, CT start-To-Groin Puncture $\leq$60 minutes, and Puncture-To-Device $\leq$20 minutes are the formula for Door-To-Device and are based on Best Practices applicable to this community hospital.

Eligibility Criteria: To be eligible to participate in this doctoral project, you must be an ED staff RN, ED Quality RN, or Neuro-intervention RN responding to the emergent code stroke patients that present to the PITSTOP in the ED. Because code strokes are dependent on real patient emergencies, all ED staff RNs are invited to observe the efficiency of the PITSTOP during this one month training/start-up phase.

Approximate time: The goal will be for the ED RN and Quality RN to expedite throughput to the angio-suite with handoff to the Neuro-intervention RN by 60 minutes from patient's hospital arrival.

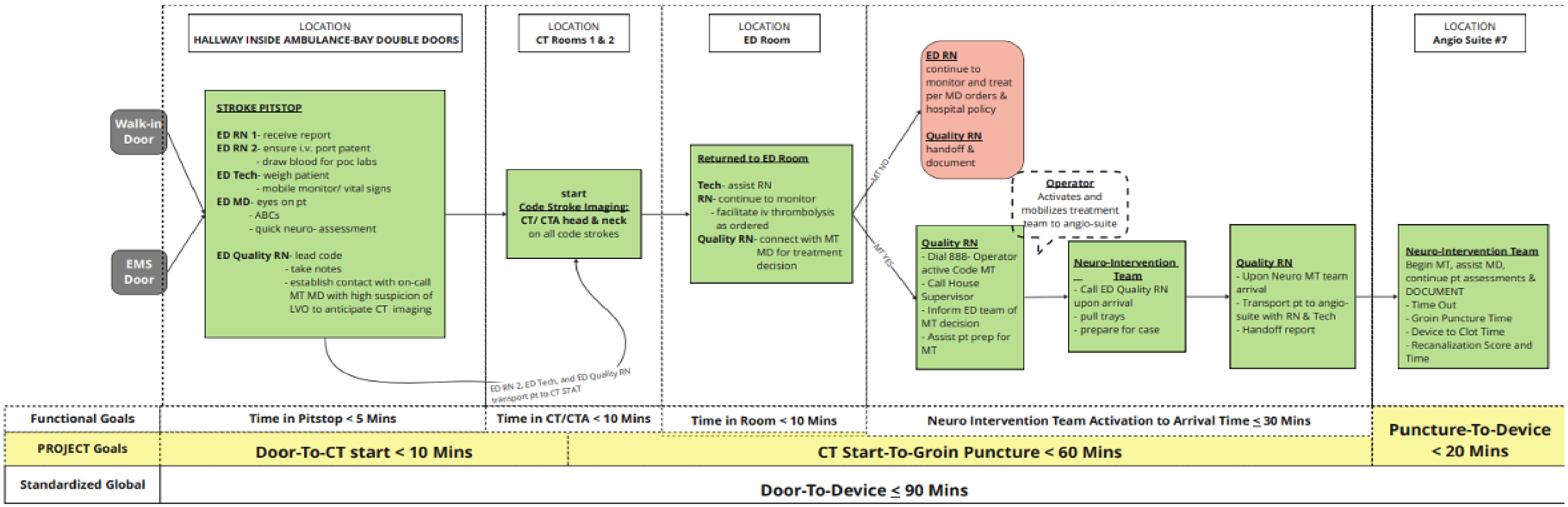
PI Contact information: You may contact the investigators regarding your rights as a participant.

If you have any questions or concerns, you may reach the Principal Investigator of this project, Dr. Tailakh, Ayman at atailak@calstatela.edu.

The co-investigator, Helaine Kauffman can be reached helainekauffman@csu.fullerton.edu.

Appendix F

The Code Stroke Pit Stop Workflow Training Tool



Note. Mechanical Thrombectomy (MT), Large Vessel Occlusion (LVO) stroke, Quality RN is the staffed separately and is Code Leader, RN #2 manages direct patient care until handoff.

All suspected strokes go directly to the PITSTOP in Hallway 1

Functional Goals are unit-based and provide a goal for time spent in each area.
PROJECT Goals are evidence-based, nationally benchmarked quality performance metrics, and the outcome measures of this doctoral project.
Standardized Global (goal) is the single MT program performance metric that is used for benchmarking, to maintain advanced stroke certification, and for EMS designation.

Additional information on backside

CODE STROKE for MT workflow notes:

new **PITSTOP** (located in Hallway 1, inside by ambulance bay)

- All code strokes arriving to the ED will be brought to the PITSTOP
- PITSTOP is stocked with dedicated stroke gurney (weighted)
- Unit Secretary overhead pages "Code Stroke PITSTOP"
- Two staff RNs, one ED Tech, one ED MD, and one Quality RN respond to PITSTOP immediately
- *ED Tech- assist patient transfer to weighted gurney and measure weight (clear for accuracy), attach mobile monitor and run vital signs
- *ED RN 2- hear report, ensure patent i.v., draw blood to hand to RN 1, and assume direct care of patient until handoff
- *ED RN 1- obtain report, collect all information, run blood through POC, send tubes to lab, then document in EHR
- *ED MD- ABC's, quick neuro-assessment, and confirm safe to go to CT for imaging
- *ED Quality RN- the CODE LEADER, shepherds quality throughput, stays with patient, manages all communication for coordination to the angio-suite for mechanical thrombectomy (MT)
- ED Quality RN contact the on-call MT MD stat for patient presentation highly suspicious of large-vessel occlusion (LVO)
- ED Tech, RN 2, and ED Quality RN go with patient to CT for imaging

GOAL TIME in PITSTOP: ≤5 minutes

GOAL TIME in CT: ≤10 minutes for CT and CTA of head and neck

- *ED Quality RN contact on-call MT MD for intervention decision
- Return patient to ED room- RN 2 continue to monitor patient per hospital stroke protocol

GOAL TIME in ED ROOM to MT DECISION: ≤10 minutes

*****If NO MT, continue standard emergency care per policy*****

If yes to MT

- *ED Quality RN notifies ED unit leadership, the hospital Operator (888), House Supervisor, and assists ED RN prepare the patient
- the Operator activates and mobilizes the on-call Neuro-intervention team including the MT MD
- Upon arrival to the angio-suite, the Neuro-intervention team calls the ED Quality RN

GOAL TIME for Neuro-intervention team ARRIVAL from ACTIVATION: ≤30 minutes (per policy)

- Neuro-intervention team immediately prepares room MT patient per unit-based process improvement
- * ED Tech, RN 2, and ED Quality RN transport patient to Angio-suite #7 (or per ED Quality RN direction)
- RN 2 and ED Quality RN provide hand-off to Neuro-interventional team RN

Appendix G

Data Results

Table G3: Descriptive Statistics

Mean and Standard Deviation of stroke care performance and quality metrics before and after the new workflow

Variable	TIME	N	Mean	Std. Deviation
1st MD Contact (minutes)	Pre-Intervention	97	17.88	17.03
	Post-Intervention	123	11.44	10.03
Door to CT start (minutes)	Pre-Intervention	97	30.16	22.21
	Post-Intervention	124	30.94	24.37
Door to Needle (tPA) (minutes)	Pre-Intervention	8	80.25	37.69
	Post-Intervention	8	57.13	33.63
Door to Groin Puncture (minutes)	Pre-Intervention	3	124.00	37.80
	Post-Intervention	2	62.50	9.19
Door to Device (minutes)	Pre-Intervention	1	157.00	
	Post-Intervention	2	149.50	0.71
Initial NIHSS	Pre-Intervention	94	7.22	8.95
	Post-Intervention	110	5.64	7.54
DISCHARGE NIHSS	Pre-Intervention	76	4.53	7.25
	Post-Intervention	46	3.15	5.24
NIHSS Improvement	Pre-Intervention	76	1.84	6.06
	Post-Intervention	39	1.54	5.64

Table G4: Data Analysis

Independent Samples t-Test

Variable	t	df	p	Mean Difference	95% CI of the Difference	
					Lower	Upper
1st MD Contact (minutes)	3.49	218.00	0.00	6.44	2.81	10.07
Door to CT start (minutes)	-0.24	219.00	0.81	-0.77	-7.03	5.49
Door to Needle (tPA) (minutes)	1.29	14.00	0.22	23.13	-15.18	61.43
Door to Groin puncture (minutes)	2.15	3.00	0.12	61.50	-29.48	152.48
Door to Device (minutes)	8.66	1.00	0.07	7.50	-3.50	18.50
NIHSS Improvement	0.26	113.00	0.80	0.30	-2.01	2.61

Appendix H

IRB Letter of Approval for Exemption from Research

Office Memorandum

DATE:	October 25, 2023
TO:	Ayman Tailakh, Ph.D
FROM:	LaTreshia Scott
PROJECT TITLE:	[2100551-1] EFFICIENT MECHANICAL THROMBECTOMY: SAVING BRAIN AND SAVING LIVES
REFERENCE #:	23-30X
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	October 25, 2023
REVIEW CATEGORY:	Exemption category # *4(ii)*

Thank you for your submission of New Project materials for this project. The California State University, Los Angeles (Cal State LA) IRB has determined that this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

IF ANY CHANGES ARE MADE TO THE METHODS AND PROCEDURES DESCRIBED IN THIS PROTOCOL, YOU MUST SUBMIT A MODIFICATION APPLICATION SO THAT THE PROJECT MAY BE RE-EVALUATED FOR EXEMPTION FROM IRB REVIEW.

For any inquiries about this project, please use the Send Project Mail option on IRBNet to contact LaTreshia Scott. **It allows us to keep all correspondence related to this project in one place, rather than scattered between IRBNet and emails.**

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within California State University, Los Angeles (Cal State LA) IRB's records.

Appendix I

Letter of Organizational Support

Providence Holy Cross Medical Center
15031 Rinaldi Street
Mission Hills, California 91345-9600
(818) 365-8051

www.providence.org/holycross

Providence
Holy Cross
Medical Center

August 11, 2023

Subject: Organizational Support for Quality Improvement Project - A Quality Improvement Process for Mechanical Thrombectomy in Large-Vessel Stroke: Saving Brain and Saving Lives

Dear California State University Fullerton DNP Program,

We are pleased to confirm our full support for Helaine Kauffman RN in the execution of her Doctor of Nursing Practice (DNP) project titled "A Quality Improvement Process for Mechanical Thrombectomy in Large-Vessel Stroke: Saving Brain and Saving Lives." This project aims to develop and implement a workflow protocol to expedite the throughput to mechanical thrombectomy, utilizing the latest evidence-based practices.

As an organization, we are committed to providing the necessary support and resources to facilitate the successful implementation of this project within Providence Holy Cross Medical Center. We will offer on-site guidance and ensure the provision of appropriate resources as required. Additionally, we will assist in obtaining any necessary approvals for data collection and storage in accordance with our local site requirements and institutional policies and procedures.

We are pleased to designate Neha Mirchandani, the Stroke Medical Director of Providence Holy Cross Medical Center, as the site organizational sponsor for this project. Dr. Mirchandani's extensive experience and qualifications make her well-suited for this role, and she will provide guidance and oversight throughout the project.

To safeguard patient privacy and comply with regulatory requirements, all data used for this project will undergo a rigorous de-identification process. Personally identifiable information (PII) and protected health information (PHI) will be removed before being made accessible to the project lead.

We firmly believe that this quality improvement initiative has the potential to significantly enhance the performance of our standard benchmarked process and improve outcomes for patients with large-vessel stroke. We are confident in Helaine Kauffman RN's dedication and expertise in leading this project, and we look forward to witnessing the positive impact it will have on our organization and the broader medical community.

Should you require any further information or have any questions, please do not hesitate to contact me at 818-496-4544. Thank you for your attention to this matter.

Sincerely,

Bernie Klein, MD
Chief Executive