Training EMS Providers to Use, Document, and Report an LVO Scale to Hospitals

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A Scholarly Practice Project presented to the Graduate Faculty
of the University of Virginia in Candidacy for the Degree of
Doctor of Nursing Practice

School of Nursing

University of Virginia
May 2019

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Acknowledgements

I wish to acknowledge the love and support of Heather, Caitlin, Haley, Amelia, Sam, Clara and Adeline; my family for time and eternity.

I wish to thank Dr. Andy Southerland, Ms. Valarie Quick, Chief Kevin Boyer, Ms. Karen Braden, Mr. Jim True, and Mr. Haydon Pitchford for their insight and support of this project. It would have been impossible to connect so many nuances of stroke care across such a broad range of providers without your help and expert insight.

Thank you to the EMS Agency Operational Medical Directors, Dr. George Lindbeck, Dr. Bill Brady, and Dr. Jeff Young.

Thank you to Dr. Ivy Hinton for sharing your expertise and demystifying the calculations and data.

This project would have been impossible without the tireless dedication of the men and women of EMS, MEDCOM, and the ED who answer 911 every time it is called.

A heartfelt thanks to Teresa, Tas, and Katie O' for peer edits, thought provoking discussions, and encouragement.

Abstract

Background: Stroke is a leading cause of death and disability among adults in the United States. Alteplase and thrombectomy are the only two FDA approved interventions for acute ischemic stroke. These interventions are time sensitive. Guidance from the American Heart Association (AHA) encourages EMS providers to triage acute stroke patients to thrombectomy capable stroke centers if there is clinical concern for a large vessel occlusion (LVO). Through the use of LVO scales and effective communication patterns, institutions are better informed prior to EMS arrival and able to active a stroke pre-alert and prepare for timely intervention.

Problem Statement: Quality metrics at academic medical center (AMC) demonstrated opportunities for improvement in stroke pre-alert times and other quality stroke metrics to more closely mirror national benchmarks.

Aim: Framed in Donabedian's (2005) structure-process-outcome, the aim of this QI project was to educate emergency department (ED) staff and medical communication center (MEDCOM) dispatchers at an AMC, and EMS providers at select agencies to use, chart, and report the Vision Aphasia Neglect scale (VAN); an LVO scale., with a goal of improved pre-alert and quality stroke metrics.

Methods: A training curriculum that added VAN to EMS's stroke assessment, charting, and reporting protocols was presented by a DNP student to EMS providers (at Agency A, B &C), dispatchers, and ED nursing staff throughout the academic medical center's service area. Post education and VAN implementation data was compared to a historic sample. The outcomes of the VAN project were measured using the stroke care metrics of pre-alert, door to alert, door to team, door to CT, and door to needle times.

Results: 245 EMS, ED, and MEDCOM providers were trained to use VAN during the project. The highest percentage of EMS providers trained in VAN were at Agency A, who also had a significant increase in percentage of pre-alert from 15.4% to 66.7% (p=.015). Aggregate improvements were demonstrated by an 18.9% increase in the percentage of stroke pre-alert (p=.051) and 5:51 minute reduction in door to team time (p=.207).

Conclusion: Interdisciplinary integration and synchronization of LVO assessment and reporting into EMS stroke protocols can improve systemic response to the care of stroke patients as evidenced in some stroke quality care metrics. This project highlights not only the opportunity to enhance quality stroke metrics but also the novel role of the DNP-prepared clinician in incorporating evidence into practice through the establishment of joint efforts among community EMS providers and academic medical center clinicians. Such collaborative interventions improve efficiency, augment care performance and reduce siloed approaches.

Key Words: stroke, EMS, stroke scale, large vessel occlusion, stroke alert, communication

Table of Contents

Introduction

Stroke is an emergency. Stroke accounts for 1 in 20 deaths in the United States. It is also a leading cause of disability among adults and costs about $34 billion annually (National Center for Chronic Disease and Health Promotion, 2017). Stroke can be classified into two general categories: ischemic and hemorrhagic. Ischemic stroke accounts for 87% of strokes and hemorrhagic strokes (both intracerebral and subarachnoid hemorrhages) account for about 13% of strokes in the United States annually (American Heart Association “Types of Stroke”, 2018).

Effective stroke treatment requires prompt intervention. To date, the only FDA approved pharmacologic intervention for acute ischemic stroke is alteplase (Activase®, TPA) (American Heart Association, n.d.). TPA must be administered in less than 4.5 hours from time last normal when it us used to treat ischemic stroke (National Guideline Clearinghouse, 2015). Because of time limitations and safety concerns associated with administering TPA, it is only administered to 3.7% of acute ischemic strokes (American Heart Association, n.d.). Revascularization through endovascular treatment (EVT), also called thrombectomy, in an interventional radiology suite is also used to treat acute ischemic stroke (American Heart Association, n.d.). Recent research from the DAWN trial indicates that a thrombectomy may prove helpful in a small portion of ischemic stroke patients up to 24 hours from time last normal (Nogueira, et al., 2018). Additionally, some hemorrhagic strokes may be amenable to treatment in the interventional radiology suite (American Heart Association, n.d.).

The imperative is rapid implementation of time sensitive acute stroke interventions because more time without adequate blood flow leads to more dead neurons (Saver, 2006). The

American Heart Association's (AHA) Target^{sm}: Stroke tiered performance recognition program through participation in Get with The Guidelines ® (GWTG), and The Joint Commission's (TJC) disease specific certification programs qualify an organization's stroke response through measurable and benchmarked time intervals based on arrival time to Emergency Department (ED) door; for example, door to CT, door to needle for TPA, and door-to-groin puncture for EVT (American Heart Association "Target^{sm}: Stroke", 2018) . Pre-alerting the stroke response team and door to alert of the stroke response teams are also reported to GWTG and reviewed during TJC disease specific stroke center audits. Therefore, the efficiency of pre-alerting stroke response teams and the door to alert timeliness of the teams is a critical component of high-quality stroke care.

Documented organizational efforts to improve and streamline stroke response include utilizing EMS to ED patient reports that are provided over radios or cell phones to activate the stroke response team prior to arrival (Wang, et al., 2017). However, other evidence suggests there may be knowledge gaps within the ranks of EMS providers and communication gaps in prehospital communication plans that hinder appropriate identification and routing of stroke patients or delays alerting stroke teams (Althubaity, Yunus, & Khathaami, 2013; Hodell, et al., 2016).

Incorporating an instrument to effectively identify stroke and large vessel occlusion (LVO) patients early is an opportunity to close the gaps. Debate continues among stroke, emergency, and prehospital clinicians about which instrument is most sensitive and specific at screening for potential LVO in a prehospital setting. Historically, the National Institute of

Health Stroke Scale (NIHSS) has been widely accepted as the standard scale for clinically quantifying stroke symptoms, in research, and programs such as Target[sm]: Stroke. The NIHSS is bulky and arguably inappropriate in a chaotic prehospital environment though. The utility of any stroke and LVO instrument in a prehospital setting is dependent on reliability, usefulness in an evolving environment, and the ability to administer it in a timely manner. In other words, a good prehospital LVO instrument must be easy to remember, easy to use, reliably performed, and quickly administered while moving from point of injury to a hospital. While some LVO instruments are developed within existing stroke scales such as the NIHSS, others are coordinated or performed as addendums to stroke screening tools such as the Cincinnati Prehospital Stroke Scale (CPSS). The stroke Vision Aphasia Neglect (VAN) scale is an LVO instrument that is appropriate for use in coordination with any stroke scale (e.g. the CPSS; or Face, Arms, Speech, Time) (Teleb, Ver Hage, Carter, Jayaraman, & McTaggart, 2017). VAN is an assessment instrument that can be completed quickly, is easy to remember, and easy to perform.

This QI project questioned if training EMS providers, MEDCOM dispatchers, ED clinicians, and stroke team clinicians to use, chart, and report VAN would increase the percentage of prehospital alerts and improve door to alert, door to team, door to CT, and door to needle times for EMS transported adult stroke patients.

Review of Literature

This literature review intended to explore which stroke scales and LVO instruments are practical in a prehospital environment and available to EMS providers to identify stroke warning signs before an adult patient arrives to the ED. Figure 1 outlines of the literature search process.

PubMed, CINAHL, and Web of Science were searched with the term, '(EMS or EMT or Paramedic) AND (stroke assessment or large vessel occlusion) AND (stroke scale or stroke tool or large vessel occlusion tool)'. The searches were limited to literature no more than 10 years old in peer reviewed publications. Included articles demonstrated primary sourced data of EMS providers' assessments of suspected stroke patients using a stroke scale or LVO instrument. Exclusion criteria eliminated articles that investigated hospital/EMS response to the related topics of cardiovascular emergencies, emergency dispatcher/911 operator triage or response to suspected stroke calls, articles not available in English language, stroke assessment with mobile stroke units, and stroke assessment using telemedicine platforms. One-hundred forty-one articles were returned in the search. Duplicates were removed before inclusion and exclusion criteria were applied to title and abstract review. Twenty-three articles were collected for full text review. A summary of this literature is presented in Appendix A.

Stroke Scales

Establishing the role and describing the impact of EMS in stroke care was a recurring theme that paralleled many stroke scale studies in the prehospital setting. For example, one study aimed to describe the sensitivity of EMS stroke assessments using CPSS (Gropen et al., 2014). They found EMS provider's bias was to over diagnose to achieve sensitivity for acute stroke.

Much of the reviewed literature investigates positive predictive value (PPV), negative predictive value (NPV), sensitivity, and specificity of stroke and LVO scales. Generally, stroke and LVO scales must be performed in tandem or LVO risk calculated within a scale's results.

Smith et al. (2018) conducted a meta-analysis of available research and found 34 different scales in 36 studies. They concluded none of the scales were statistically significantly superior at identifying large vessel occlusion. The most commonly reviewed stroke scales were the CPSS, the Los Angeles Motor Screen (LAMS), abbreviated versions of the National Institute of Health Stroke Scale (NIHSS), and the Los Angeles Prehospital Stroke Scale (LAPSS). Validation of scales were often accomplished through retrospective chart review of novel scale score, imaging, NIHSS score calculated stroke expert, and discharge diagnosis.

Further review of several stroke scale studies indicated the scales were assessed in various settings and/or by various providers, including EMS providers in a prehospital setting. The scales and scores of these assessments were then compared to a neurologist's assessment and scoring using the NIHSS, imaging, and discharge diagnosis. These studies reviewed the Rapid Arterial oCclusion Evaluation (RACE), Cincinnati Stroke Triage Tool, CPSS, NIHSS scale-8, sNIHSS-EMS, and the NIHSS (Purrucker et al., 2017; Kim et al., 2017; Asimos et al., 2014; Demeestere, 2017; Pérez de la Ossa, et al., 2014; McMullen et al., 2017; Studneck, Asimos, Dodds, & Swanson 2013; Kesinger, Sequeira, Buffalini, & Guyette, 2014; & Richards et al., 2018). Most of these trials were tantamount to feasibility, validity, and pilot testing of a specific scales or efforts to validate a scale for LVO sensitivity. Many researchers' arguments for the use of one scale in a prehospital setting relied less on the utility within the fluid prehospital environment and more on the PPV, NPV, specificity, or sensitivity. Limitations were often described in terms small sample sizes, single center testing sites, or flawed designs that potentially introduced bias.

Studies on EMS Prenotification and Handoff in the Emergency Room

Literature on prenotification and handoff was discovered either through ancestral search of other articles in the literature review or during the literature review itself.

Spencer, Khan, Bobrow, and Demaerschalk (2009) aimed to describe the role of EMS in the thrombolytic treatment of acute stroke. They found that EMS providers were accurate at identifying stroke 88% of the time using the CPSS. They concluded that EMS communication was an important component of timely thrombolytic treatment of acute stroke.

Lin et al. (2012) investigated the effects of EMS prenotification on stroke quality metrics like door to alert, door to CT and door to needle times. Their data was collected from GWTG. They found EMS providers prenotify hospitals of incoming stroke patients about 67% of time. They concluded that prenotification is underused despite a potential bias because high performing organizations provided data to GWTG.

Enlightening to this review of EMS stroke response were two qualitative studies of EMS perceptions of stroke response. Stroke scales and transportation decisions were discussed in these articles. Both studies essentially aimed to identify barriers in prehospital stroke treatment, identify which stroke instruments were used, and provided insight into challenges of stroke assessment in the prehospital environment. Althubaitly et al. (2013) found that EMS providers in Saudi Arabia were not using stroke assessment instruments and transported patients to the closest hospitals regardless of the hospital's capabilities to administer TPA or perform EVT. A study by Hodell et al. (2016) surveyed of EMS providers described barriers to care related to "so many types of strokes, rapport between EMS staff and physicians, and follow up on cases". This small cohort of EMS providers in California also reported inexperienced medics were not using stroke instruments during assessments.

Another qualitative study by Najafi, Fereidouni, Sarvestani, Hadian-Shirazi, and Taghinezhad (2017) described different perspectives of EMS and ED clinicians as variables in patient handoff. They identified potentially catastrophic information loss because the environment of handoff is labile (e.g. bedside, or nurses' station or hallway), the information is sophisticated, and time is limited. Meisel, et al. (2015) in a qualitative survey of EMS providers in the United States found that handoffs were not performed in standard formats or with a handoff tool (e.g. IPASStheBATON or SBAR). They also described common barrier as time limitation, labile location in the ED, and variable staff presence at the report.

Prioritizing transport

Milne et al., (2017) aimed to address the EMS stroke paradigm referred to as drip 'n' ship vs mothership through a modeling study of the western United States and Canada. The paradigm begs the question should EMS bypass TPA capable primary stroke centers (PSC) for comprehensive stroke centers (CSC). This model included variables such as weather, time of year, time of day, distance, terrain, and stroke severity. Their findings indicate that drip 'n' ship is only beneficial if the PSC is able to administer TPA less than 30 minutes from the time the patient arrives at the facility (e.g. door to needle time < 30 minutes). After thirty minutes, the CSC is predicted to have better outcomes provided the CSC is able to administer TPA less than 60 minutes after the patient arrives. EMS pre-alert was identified as a key component of treatment. Bypass benefits are also dependent on the difference in transport time between the

PSC and the CSC. That is to say, the benefits of mothership over drip n ship varied between rural and urban location because transport times are generally longer from rural PSCs to urban CSCs. Generally speaking, outcomes were predicted to favor CSCs, notwithstanding increased transport times up to 30 minutes. This study provides low grade evidence in support of bypassing PSCs for CSCs. It also highlights the role of EMS in quality stroke care.

Benoit et al. (2018) also developed models to address the paradigm of bypassing PCS for treatment at CSCs. Their models provided compelling information that highly sensitive large vessels occlusion scale diminished the utility of the scale for bypass decision making. Similar to other research, the benefit and risk of bypass was variable and poor outcomes were likely for both false positive and false negative large vessel occlusion assessments.

The American Heart Association Mission: Lifeline® Stroke (Panagos, Schwamm, Lugtu, & Paulsen, 2018) is an example of a best practice guideline aimed to improve systemic response. The Mission: Lifeline® Stroke Severity Decision algorithm for EMS is based on likelihood of LVO (The Mission: Lifeline® Stroke Severity Decision Algorithm). The guidelines were developed after years of debate regarding stroke severity, triage, routing, and communication between EMS and hospitals. Mission: Lifeline® Stroke indicates only patients for whom an EMS provider determines there is a clinical suspicion of LVO stroke should bypass PSC for thrombectomy capable CSCas long as bypassing a PSC adds no more than 15 minutes to transportation time. Per these best practice guidelines, EMS providers assess for LVO using a vetted instrument. Patient status and decision making from the field must also be communicated to receiving hospitals so that EVT resources can be activated prior to patient arrival.

Stroke VAN

Teleb, et al. (2016) developed and tested VAN in an urban health system in the southwestern United States. The researchers demonstrated adequate PPV (0.74), sensitivity (1.00) and specificity (.90) in their single center test of VAN. In the VAN study protocol, ED nurses were charged with calling stroke alerts based on their VAN score. Teleb et al. (2016) also indicated their intent was to use VAN in a prehospital setting and describe the utility of VAN as easily remembered, does not require calculations, and can be completed in 15 seconds.

Gaps

Several gaps exist in the literature. Large scale randomized clinical trials to support the use of one LVO scales over another LVO scale do not exist. The available evidence on stroke scales is mixed, with no one scale identified as most efficient or effective. As a result, the AHA guidelines serve as the best evidence for early identification, triaging transport, and emergency management of suspected stroke patients in the field. In this guidance, EMS providers should assess stroked warning signs with vetted stroke and LVO instruments, and healthcare organizations should activate inpatient resources based on EMS reports. Nevertheless, pre-notification based on EMS reports is not practiced as a standard protocol in all healthcare systems. This literature search did not yield studies that investigated the relationship between pre-alert and timed stroke quality metrics such as door to alert, door to team, door to CT read, and door to TPA infusion. Lastly, barriers to communication between EMS providers and EDs are fairly well described in qualitative studies. But, review of quantitative studies that attempted to measure and mitigate these barriers between EMS and healthcare systems in the context of stroke care were not reviewed.

Practice Discussion

In practice, stroke providers connect a complex clinical picture including physical exam, medical history, present illness with CT, MR imaging, and/or endovascular therapy to develop the clinical diagnosis of acute stroke and develop an appropriate care plan (Caplan, 2009; Caplan 2018). EMS reports from the field are an important element of this clinical picture and stroke system activation. There is concern that critical information from the field may not make it to stroke providers for many reasons.

Several stroke tools exist to aid in assessment in various settings. Despite the availability of several stroke and LVO instruments, not all are aptly applied in the prehospital setting. As a case in point, there is little utility for EMS providers to perform an NIHSS in the back of a moving ambulance because the NIHSS is complex, time intensive, and scoring requires calculation of several subscales. Prehospital stroke and large vessel occlusion instruments are intended to provide a reasonable PPV and NPV of a stroke and large vessel occlusion; not diagnose a stroke or large vessel occlusion in a prehospital setting.

Given the array of available stroke scales and lack of demonstrated superiority of any of the scales, VAN is a reasonable instrument for implementation in the prehospital environment which translates clearly to the emergency department and stroke teams upon arrival.

Purpose

The propose of this project was to introduce the VAN assessment instrument, standardize prehospital stroke and LVO assessment with the VAN scale, and include VAN in reporting and handoff protocols between EMS and ED.

Methods

Recent best practice guidance from the local EMS council and the AHA suggest protocolizing LVO assessment as part of pre-hospital stroke assessment to triage suspected LVO strokes to thrombectomy capable stroke centers. Further, EMS providers should include stroke and LVO scale results when reporting patient status to receiving EDs (Panagos, et al., 2018; Thomas Jefferson EMS Council, 2017)

Training Curriculum Development

A current state analysis was conducted prior to implementing the VAN education effort of this QI project. During this four-week effort, data from GWTG was reviewed with three stroke team leaders to identify quality metrics that were amenable to intervention. The preliminary curriculum, draft study question, and data from GTWG were presented to two operational medical directors, the MEDCOM manager, lead MEDCOM dispatcher, the EMS liaison, lead prehospital trainer, a training chief from Agency A, two clinical nurse specialists with critical care backgrounds, the ED nurse education coordinator, a research coordinator in the department of neurology, and two paramedics not associated with the targeted agencies. The final VAN curriculum, EMS protocol, MEDCOM protocol, and ED nurses standard work reflected these stakeholder’s feedback and input.

Definition of Terms

See Appendix B.

QI Design

This QI project incorporated a pre and post-intervention evaluative design with an educational intervention to introduce a standardized LVO assessment instrument and interdisciplinary communication process. Data elements of outcomes and compliance were collected after efforts to train stakeholders started. The data points were compared to a similar time period from the previous year.

The project was designed within the framework of Donabedian's (2005) Structure - Process -Outcome quality of care model which was validated by Moore, Lavoie, Bourgeois, and Lapointe (2015) in a trauma system (See Figure 2). This project capitalized on the current EMS-to-ER structures, standardized the process of prehospital LVO surveillance within the existing stroke assessment guidelines, and evaluated the outcomes of stroke team pre-alert, door to alert, door to team, door to CT, and door to needle quality stroke metrics.

Setting

The setting was a rural academic medical center ED with 56 beds, the affiliated MEDCOM dispatch system, and three of the 20 EMS agencies in the rural service area. The academic medical center was recognized as a CSC through The Joint Commission disease specific certification just prior to sample group of year 1. They participated in the AHA's Target^{sm}: Stroke tiered recognition program by providing data to GWTG during both time periods.

The EMS agencies, MEDCOM and ED typically care for over 425 diagnosed strokes annually. The CPSS was listed in the governing EMS council's patient care guideline for assessment of stroke. There was no LVO instrument, triage guidance, or reporting guidelines to optimize care for these patients in this document (Thomas Jefferson EMS council, 2017).

Description of Sample

The educational intervention focused on local EMS agencies, MEDCOM dispatchers, and ED nursing staff (registered nurses and ED technicians). The three participating EMS agencies employed approximately 377 EMS providers with state and nationally recognized credentials. The 17 MEDCOM dispatchers maintain similar credentials as EMS providers. The ED employs approximately 149 nurses and ER technicians. The ED and its associated physician residency program include approximately 60 physicians who collaborate with 32 stroke team attending and resident physicians during stroke alerts.

A wide range of providers with varying professional backgrounds participated in the training. Prehospital providers and MEDCOM dispatchers included Emergency Medical Technician-Basic (EMT-B), Emergency Medical Technician-Intermediate (EMT-I), and Nationally Registered Paramedics. ED staff included ED technicians who were EMT-Bs or certified nursing assistants, licensed practical nurses (LPN), registered nurses (RN), nurse practitioners (NP), physicians' assistants (PA), and both resident and attending physicians in the ED. Stroke team clinicians included resident and attending physicians, NPs and RNs. The principal investigator (PI) had no supervisory authority over the participants. The EMS agencies trained to use VAN and the communication protocol transported 47.6% of the prehospital stroke patient volume at the academic medical center in the year 1 sample.

The three participating EMS agencies were staffed by professional and volunteer EMS providers with licensure ranging from EMT-Basic to nationally registered Paramedics. Not all these EMS providers work on ambulances through. For example, Agency A and Agency B employ firefighters who maintain EMT-B certifications, but never work on an ambulance. Agency C is a volunteer rescue squad with a robust roster of lifetime members and several members who only volunteer for special events.

All these agencies respond to suspected stroke with advanced life support (ALS) capable paramedics and EMTs. They employ state of the art communication radio equipment during reports to MEDCOM. This equipment includes radio and cellphone equipment for both communication and plain text messaging. These agencies also coordinate staff in-service and continuing education with the academic medical center through the academic medical center's EMS liaison.

Electronic health records (EHR) of patients > 18 years old who arrive by EMS and had a stroke alert called while the patient was in the ED were reviewed by the PI. Patients that were transferred from partner hospitals for stroke, patients that are hemodynamically unstable due to respiratory or cardiovascular compromise (e.g. cardiac arrest, respiratory arrest, and myocardial infarction), and patients with major traumatic injuries (e.g. traumatic injury that threaten life, limb or eyesight) were excluded from the data analysis. The medical center EHRs included scanned documents from MEDCOM dispatcher and some EMS patient encounter records (often referred to as run sheets). Some EMS transported patients were pre-alerted, but lacked the documentation to assess the EMS report to the ED. As such, encounters that were missing critical data like stroke scale through MEDCOM were excluded from final calculations.

Procedures

Protection of human subjects

Institutional review board (IRB) approval was granted prior to implementing training or collecting data. The IRB classified the initiative as a QI project. Protecting privacy was paramount during data collection. While the review of the EHR and EMS run sheets meant the PI was accessing personally identifiable healthcare information, all patient data was deidentified in the project data set. Potential patient encounters were first reviewed in a briefed format through the academic medical center's stroke database. Patients' full charts were only accessed for project specific data if they arrived to the ED via EMS. Other efforts to deidentify patient data included recording ages >75 as '75 years old'. Stroke alert encounters were identified by a unique alpha numeric number assigned by the PI. Data was collected and stored on a secure server owned and operated by the academic medical center. The server was accessed in a stroke team office at the academic medical center or in the health science library of the affiliated medical school.

Stakeholder Education

A goal of 75% of nursing and EMS personnel fully trained in VAN was established after input from stakeholders and prior to data collection. Education was provided at mutually convenient times over a six-week period in August and September of year 2. A variety of the training material and methods were used during the training effort; including multimedia slide shows, flip charts, digital message board posters, and online videos produced by the VAN scale developer and partner agencies.

A standardized training model and plan is presented in Appendix C & D. A reference card, which was posted in ambulances near their radios and in the ED near treatment areas, is presented in Appendix E. The multi-media slides used in training and in the flip-charts are in Appendix F. Appendix G is an EMS stroke guidelines and protocol provided to EMS agencies during the project. Appendix H is a proposed stroke report protocol that includes VAN for MEDCOM dispatchers. Appendix I is a proposed standard work for handoff and charting VAN for ED nurses. All stakeholders were provided with digital and hard copies of training material.

Lesson plans included time for didactic presentation of VAN, an instructor demonstration of the assessment, a brief-back period for learners to review and demonstrate VAN, and time for questions. A posttest was offered to EMS providers at the request of the EMS training chiefs. These tests were maintained by the EMS agencies for their training records and continuing education hours.

Training was conducted by either the PI or the UVA EMS liaison, or EMS training chiefs. Training rosters were used to track training progress. Training was presented in the preferred format of the trainer and to accommodate the learners' environment and time constraints. Training sessions ranged from 15-30 minutes depending on the audience's participation, and available time (some Fire/EMS crews responded to emergencies during the training). Hip-pocket training, meaning training at a time and in an environment convenient to the clinicians work day, was the primary mode of education at Agency A, MEDCOM, and in the ED. Agency B and Agency C received VAN training at scheduled staff meetings.

The training environments included classrooms, conference rooms, breakrooms, fire station garages, and other working areas. Training and scaffolding material were provided for display in breakrooms, common areas, on ambulances, and in other work areas to reinforce elements of the VAN instrument and encourage charting.

Assessment and communication

The VAN instrument was used in conjunction with CPSS in the fluid environment of the EMS prehospital setting as the patient progressed from point of injury to transportation to the hospital then handoff of care in the ED. The point of injury ranged from a patient’s home to community venues to skilled nursing facilities. Point of injury did not alter the project plan or response. Progression of care was standard from point of injury to the back of the ambulance to transport to a hospital to arrival at the academic medical center’s ED.

Data Collection Procedures

Data collection started in Fall of year 2 and lasted 16 weeks. The academic medical center’s stroke database was searched in two date groups, six weeks of September through November year 1 and September through November year 2. This database collated all stroke alerts at the academic medical center during the described timed periods.

The primary source for documentation this project was the hospital EHR. ED nurse quick notes, *Stroke Alert Notes,* stroke team patient progress notes, imaging results, MEDCOM *Patient Information Sheets*, and/or the EMS run sheets were reviewed to collect project relevant data. This data included patient demographics, description of patient condition, outcomes of stroke instrument assessment, information to calculate stroke quality care metrics, and discharge diagnosis. The review of the patient’s chart stopped when project relevant data was collected or there was clear evidence that stroke was ruled out of the differential diagnosis (e.g. the ED physicians H&P did not list stroke in the differential diagnosis).

The PI collected demographic information of age, gender, ethnicity, and race as well as study information to determine pre-alert, door to alert, door to team, door to CT, door to needle, door to groin puncture, stroke scale through MEDCOM, and stroke scale at report. Transporting agency was described as Agency A, Agency B, Agency C, and other. When EMS run sheets were available, they were reviewed to confirm demographics, stroke scale score, VAN instrument score, and pre-alert to MEDCOM. The data was collated on an excel spreadsheet and stored as noted above. The data was transposed to an SPSS® (version 25, IBM) file for statistical analysis.

Case feedback was provided to EMS agencies for quality control purposes through the academic medical center's EMS liaison. Systems for case feedback were in place prior to this QI project. The PI and EMS liaison augmented the efforts by coordinating direct feedback to the EMS training chiefs on a case by case basis and as requested by the agencies.

Data Descriptions and Plan

Descriptive and analytical statistics were run on all variables of interest. The denominator population for this project was all patients that were transported to the academic medical center with a suspicion of stroke that met inclusion criteria and were treated during the described time periods.

Stroke scale through MEDCOM indicated the EMS provider either reported a stroke scale or thorough enough description of symptom to deduce that a stroke scale guided EMS assessment and report. This information was available on the MEDCOM *Patient Information Sheet.* It was measured as 'yes' or 'no'. A 'yes' indicated the information in the narrative or elsewhere in MEDCOM documentation suggested a stroke scale was assessed and reported. For example, “CPSS positive” or “left facial droop, right arm weakness, and numbness in right lower extremity”. A ‘no’ indicated the data in the EHR did not bespeak a stroke scale was presented to the MEDCOM dispatcher or the description in the narrative would not qualify a positive stroke scale. For example, “stroke signs” or “confusion”. Records without a copy of the MEDCOM *Patient Information Sheet* or EMS run sheet were excluded from final analysis.

Stroke pre-alert was measured as ‘yes’ or ‘no’. A ‘yes’ meant the inpatient stroke team was alerted prior to the patient arriving to the ED. A ‘no’ meant the inpatient stroke team was not alerted prior to the patient arriving to the ED. These definitions mirrored current institutional processes and information that is reported to GWTG.

Door to alert time was calculated if a patient was assessed by the stroke team in the ED and they were not pre-alerted. This information was available in the *Stroke Alert Note* and in the academic medical center’s stroke database. Times were calculated from the time that the patient arrived in the ER to the time the stroke alert was initiated through the system. An encounter was excluded from this measure if it met criteria of stroke pre-alert. If the EHR indicated the stroke alert was sent at the same time the patient arrived, a zero was recorded. Similar, to stroke pre-alert, this information is part of national data reporting trends and is recognized as a measure of process when applied consistently across the nation.

Door to team times were measured in minutes. This metric was calculated from the time the patient entered the ED to the time the first member of the stroke team arrived at the patient’s bedside, regardless of when the stroke team was alerted. When the team arrived prior to the patient, the time was recorded as zero. This information was available in the *Stroke Alert Note* in the EHR and in the academic medical center’s stroke database.

Door to CT times were calculated from the time the patient arrives in the ED to the time the stroke team leader reviewed the non-contrast CT scan to determine if there were signs of cerebral hemorrhage. This information was available in the *Stroke Alert Note* and in the academic medical center's stroke database. Door to CT times were measured in minutes.

Data for door to needle and door to groin puncture were collected for analysis. These measures are calculated in a similar fashion to the aforementioned quality stroke metrics. The information was generally available in the stroke database or on the *Stroke Alert Note.*

Data Analysis Plan

Statistical significance was established at $p < 0.05$. Demographic nominal data and transporting agency data were compared through Chi square test to determine if there were statistically significant differences. Other nominal data, such as stroke scale through MEDCOM and pre-alert, were also compared with Chi square or Fisher's Exact tests for statistical significance between the sample groups.

Data for the effects of VAN implementation on the quality stroke care metrics, such as door to alert, were first described through descriptive statistical analysis to determine if parametric or non-parametric comparison of means was indicated. Independent *t* tests were performed on data that met parametric assumption at a 95% confidence interval, $p < 0.05$. Mann-Whitney U test were used to compare means on quality stroke metrics that did not meet assumptions of normalcy at a 95% confidence interval $p < 0.05$.

Results

Training

The pre-established training goal of fully educating 75% of the EMS and nursing staff was not met. Training efforts started prior to data collection and continued throughout data collection period. Seventy-five of 149 (50%) of ED nursing staff participated in training. Fourteen of nineteen (74%) MEDCOM dispatchers participated in training prior to and during data collection. Eighty-six of 103 (83.5%) EMS providers were trained at Agency A prior to and during data collection. Twenty-seven of 103 (26.2%) of EMS providers were trained with Agency B prior to and during data collection. Forty-three of 184 (23.4%) EMS providers were trained at Agency C prior to collecting data.

Samples

The year 1 control sample (n=38) was 55.8% smaller than the year 2 sample (n=68). All encounters included in the analysis met criteria for inclusion in the project. But, every encounter did not include data to measure every metric of interest.

Demographic and transporting agency data are presented in Table 1. The mean ages of the two samples were very similar; year 1 (n= 38) was 64.3, and year 2 was 65.8 years (n=68). Independent t test was used to compared means and was not statistically significant (p = .522).

Genders were described as male or female. No other genders were reported. No significant difference was identified based on gender (χ^2 = .44; p=.506)

Race was identified as white or non-white because of the homogeneity of the study population and small number of minorities in both samples. No significant differences were identified based on race (χ^2 =0.00; p=.960).

Data for transporting agency were collected in four categories; Agency A, Agency B, Agency C, and other agencies. Agency B medics often operated Agency C ambulances. Further, Agency B transported two or less stroke patients in each sample group. Therefore, Agency C and Agency B were combined into ‘Agency C’ for statistical analysis. Chi square testing indicated no statistically significant difference between the two samples (χ^2 =5.48; p=.064).

Stroke Scales and Reporting

Analysis by agency of stroke scale reported through MEDCOM and stroke pre-alert are reported in Table 2. Fisher’s Exact test was used instead of Chi square when crosstab had cells with values < 5. Both Agency A and Agency C increased the percentage of stroke alerts reported through MEDCOM, 46.2% to 83.3% and 44.4% to 75.0% respectively. These increases were not significant (p= .097 and p=.203 respectively). A decrease was observed in the percentage of strokes scales reported through MEDCOM by all other agencies which were not statistically significant (p=.557).

The percentage of stroke pre-alerts when Agencies A and C were transporting a patient increased. Agency A was statistically significant, 15.4% to 66.7% (p=.015). Agency C was not statistically significant. But, an increase from 11.1% to 33.3% (p=.338) was observed. All other agencies demonstrated a slight increase in the percentage of stroke pre-alerts from year 1 (37.5%) to year 2 (38.6%) and were not statistically significant (p=.936).

Aggregate analysis of stroke scale reported through MEDCOM and pre-alert percentages are reported Table 3. Figure 3 presents the aggregate change in percentages of strokes reported through MEDCOM and pre-alerts. The percentage of scales reported between year 1 and year 2 increased by 9.1%; 50.0% to 59.1% respectively. Chi square test did not demonstrate a statistically significant increase in the percentage of stroke scales reported through MEDCOM ($\chi^2 = 0.81$; *p*=.369). The percentage of pre-alerts increased by 18.9% from year 1 to year 2 and were statistically significant ($\chi^2 = 3.81$; *p*=.051); 23.7% to 42.6% respectively.

Quality Stroke Care Metrics

Table 4 and Figures 4-7 presents statistical and graphic analysis of time measured quality stroke care metrics.

Mean door to alert times decreased between year 1 (*n* = 29; *M*= 20:31 minutes) and year 2 (*n* = 45, *M* = 14:22 minutes). The data distribution did not meet assumptions of normalcy. Non-parametric Mann-Whitney U test was used to compare means and was not statistically significant (*p* = .182). Both data groups had outliers greater than three times the interquartile range, year 1- 1:52:00 hours and year 2 - 1:18:00 hours.

Mean door to team also decreased from year 1 data group (n=38, *M*=17:45 minutes) to year 2 (n=68, *M*=11:54). A zero time in this metric indicated the stroke team arrived in the ED before the patient. The data distribution was highly skewed and demonstrated kurtosis. Non-parametric Mann-Whitney U test was used to compare means and was not statistically significant (*p* = .207).

Mean door to CT increased between year 1 (*n*=38; M=25:45 minutes) to year 2 (*n*=68; *M*=29:25 minutes). The data distribution was highly skewed and demonstrated kurtosis. Therefore, non-parametric Mann-Whitney U test was used to compare means and was not statistically significant (*p* = .660).

Mean door to needle increased between year 1 (*n*=7; *M*=44:00 hours) and year 2 (*n*=4; *M*=1:15:30 hours). Data did not meet assumptions of normalcy because of the low numbers. Mann-Whitney U tests did not indicate a significant difference in means (p=.164)

There were not enough data points in the two sample groups to assess a change in mean door to groin punctures for patients that underwent thrombectomy.

Discussion

The project was successful, particularly in terms of improved percentage of stroke pre-alerts. Although statistical significance was not observed within all indicators of quality stroke care, noteworthy clinical improvements were noted with the mean door to alert and door to team times. This is especially important because it means that expert consultation for stroke patients was activated quicker or was waiting for the patient in the ED. Further, this project helped align the academical medical center and partner EMS agencies stroke treatment efforts with AHA guidance set forth in Mission: Lifeline® Stroke, and exceed standards established in Target[sm]: Stroke and by TJC for certification as CSC.

Training and Structure Challenges

Some challenges, such as a lack of dedicated training time for this type of project and the PI was a DNP student, were identified during the curriculum development. Other challenges such as staff turnover, firefighter vs EMS providers' titles and roles, and labile work flow developed as the project progressed.

Responsive to feedback during curriculum development, the training was designed and intended to be short 15 to 20-minute hip-pocket training that could be adapted to a variety of provider skill levels, in a variety of settings, and for an audience of almost any sizes. EMS stakeholders and leadership requested face to face training at the station houses or prescheduled training events rather than computer-based training to accommodate the learning style of their EMS providers. Therefore, face to face training was implemented bedside in the ED, in the MEDCOM office, and at seven different EMS stations throughout the service area.

Notwithstanding support from key stakeholders to introduce a standardized LVO assessment tool to stroke protocols, compliance to reporting and recording stroke scales proved to be a challenge; especially in the ED. Several elements of the academic medical center ED's environment and operations may account for the limited charting of EMS reports by ED nursing. First, participation in VAN training efforts were not prioritized due to competing interests of the department. Second, there were unforeseen barriers to incorporating the stroke assessment tool into the EHR. This hindered the efficiency with which the nursing staff could chart EMS reports. Assimilated in the Donabedian structure-process-outcome framework, the knowledge of the VAN scale and reporting was presented to the human structure of the system, but the structure in the EHR to support the process or recording the scale or the report of the scale was not present. Third, the ED education coordinator left their position during the education effort. This person was the primary champion for this QI project in the ED and this left a role vacancy in the ED project structure.

Long-standing processes surrounding stroke alert protocols at the academic medical center played a role in ED nurses' not recording EMS stroke reports at handoff. ED attending physicians are the only ones authorized to initiate a stroke alert in the ED. That is to say, EMS and nursing staff report stroke warning signs to ED faculty who then assess the patient and make the determination to initiate systemic stroke response.

ED nursing staff's anecdotal feedback during hip-pocket was generally positive regarding the utility of the VAN scale and the aim to enhance EMS handoff. But, many nurses felt the extra work to chart the report in a separate note was not worth the effort if they could only report outcomes to the physicians instead of initiating the stroke alert. This sense of powerlessness in the system is similar to what EMS providers reported to Hodell et al. (2016). This element of empowerment and its effects on process and outcomes is also worthy of further review in future QI efforts.

ED physicians were aware of the training effort with EMS providers and ED nurses because of the support of the EMS operational medical directors who also worked in the ED as attending faculty. Ultimately, only ED resident physicians and a few attending faculty physicians participated in a brief of the VAN project, its aim, and the VAN scale. A more engage ED faculty may have positively influenced efforts to incorporate VAN into reporting processes throughout EMS and the ED and possible the pre-alert rate.

An unanticipated challenge training EMS provider was the geographic distances between the stations. For example, much of the time spent training EMS providers in Agency A was driving from station to station then waiting for crews to return from calls. Distances often exceeded 15 miles and travel times between stations could be as much as 25 minutes. Time at the stations ranged from 45 to 90 minutes, with approximately 25 minutes dedicated to training. Other methods of disseminating training could be considered in future training efforts.

MEDCOM was the smallest and most compact of the stakeholders and easiest to access for VAN training. The few challenges encountered during training readily overcome through accommodating MEDCOM's work flow.

To summarize structure and training elements of this project, the challenges experienced during the training phase of the VAN project were not entirely unexpected. The impact of various barriers to training were most evident in lower than expected training density in some areas. Other training methods should be considered in future QI efforts with input from the stakeholders. Lastly, follow up QI efforts areas should include structural changes in the EHR that compliment workflow, stroke scale assessment, and reports to hospitals.

Stroke Care Metrics

A clinically significant improvement in the overall percentages of pre-alerts was observed year 2 (see Table 3). This notable improvement was observed notwithstanding three of 20 agencies trained and no additional structures in the EHR to scaffold VAN assessment and reporting. The increased percentage of pre-alerts was statistically significant for Agency A, who also had the highest percentages of providers trained, highest percentage of reported stroke scale through MEDCOM, and added VAN drop down menus to their patient record. Given the relatively small sample sizes and short data collection period, one might speculate that statistical and clinical significance may have correlated better if data were collected for a longer period of time and more were staff trained

Mean door to alert times decreased by over six minutes. This decrease was clinically significant. There are some caveats to the calculation that may have affected the statistical significance. Figure 4 demonstrates the outliers in both samples. These outliers were included in the final analysis because the encounters met inclusion criteria and the situations in the encounters provided compelling discussion for follow up QI projects to address pre-alert and handoff procedures. Such projects might consider pre-alerting based on EMS reports and allowing RNs to call a stroke alerts without ED attending physician's assessment. That is not to say delays in the metric of door to stroke alert are always meritless or due to a pre-occupied ED attending physicians.

Reasons a potential stroke patient may arrive to the ED without a pre-alert include an atypical presentation of stroke warning signs that may not have been identified using the CPSS. Stoke patients that come to the ED without an EMS report for stroke generally present with more nuanced stroke warning signs like isolated balance or visual disturbances. These types of stroke presentations may require greater expertise and time intensive scrutiny. Another element to consider is the aim of the VAN project was to increase the percentage of pre-alerts and decrease other stroke quality time metrics. The impact of the QI effort may primarily be realized as the increased pre-alerts since pre-alerts were removed from analysis of door to alert time. Therefore, the remaining number of EMS transported stroke patients may require more time to resolve the atypical stroke presentation.

Mean door to team times decreased by over five minutes between the two samples. This time difference was clinically significant because expert care was available faster. Effectually, the greater percentage of pre-alerts meant the stroke team arrived in the ED before the patient more often. This improvement aligns with other studies that demonstrate early systemic response is associated with improved outcomes and further aligns the 'time is brain' mantra of the stroke care community (Gumbinger et al., 2014; Saver, 2006).

Mean door to CT read time increased during the study period. This increase represents statistical variability despite the extreme outlier in the year 2. Of note, the encounter that was the extreme outlier in year 1's previous metrics did not have a CT scan because it was not clinically indicated. Analysis of Figure 6 and Table 3 reveals that interquartile ranges are similar. This suggests consistent performance in this metric and the influence of EMS stroke pre-alert may not be observed beyond a certain point in the work flow. There may still be room for improvement though.

Logic dictates that since there were no other changes to workflow in the ED stroke response, the improved door to alert and door to team times should have permeated into door to CT times. One might consider a bottleneck of work-flow in light of this observation. Efforts researchers' efforts to improve performance in door to CT times focus on streamlining care in the ED. For example, a straight to CT protocol for pre-alerted stroke patients, doing i-STAT point-of-care testing for kidney function in the CT suite and removing redundant work (Barbour & Thakore, 2017; Rai, Smith, Boo, Tarabishy, Hobbs, & Carpenter, 2016; Ruff et al., 2014; Menon et al., 2019). These interventions are beyond the scope of this QI project, but may warrant consideration for future QI efforts that address this metric

The mean door to needle time increased from year 1 to year 2. The data in this variable is small in numbers. While this may contribute slightly to the observed increase in the time to administer TPA, it was still concerning. A root cause analysis of the metric by a multidisciplinary team of physicians, nurses, pharmacists, and techs reported increased time secondary to efforts to reduce blood pressure for safe administration of TPA. While the stroke team and ED stakeholders are still developing an appropriate, safe, and agreeable response plan, this information indicates that variables extraneous to EMS assessment and reporting effect door to needle time. That is to say, the CT scan and TPA administration are potential logjams in the system of stroke care.

Structural Changes in EMS and MEDCOM To Support Better Reports

Documentation of VAN reports in the EHR were less than anticipated. Strategies to complement stroke assessment and the VAN scale within the structure of the EHR were not implemented; though they were discussed with stakeholders and leaders.

Agency A championed a different approach and nested an LVO assessment prompt and drop-down menu in their patient record. These drop-down menus were developed later in the data collection period and proved helpful when collecting data from run sheets. Within the Donabedian framework of Structure-Process-Outcome, Agency A changed its EHR structure to support the assessment and reporting process of the VAN project and increased the percentage of stroke scale elements reported through MEDCOM by 37.1%. Further, their reports lead to a significant increase in stroke pre-alerts. The outcomes with Agency A provide compelling evidence for a future QI project to improve stroke pre-alert by scaffolding stroke and LVO assessment and reporting with other structural changes in the EHR.

Strengths and Weaknesses

There are several limitations to this QI project. For example, the training was provided to three of 20 agencies that transport patients to the academic medical center and the training goal was not met prior to data collection. An improved training density and more agencies participation in the service area may demonstrate more favorable aggregate results for the entire service area in future QI efforts. Also, the lack of a standard structures to clearly demonstrate EMS's report of the VAN scale through MEDCOM notes and ED EHR call into question the relationship between the intervention and the observed outcomes. In other words, data collection intended to quantify compliance was complex and elements of compliance may have been overlooked or, at worst, not charted at all.

A strength of this QI project is that it demonstrates the ability of EMS providers to successfully use the VAN scale in their setting. To-date, the Smith et al. (2018) metanalysis of 34 different stroke and LVO scales in 36 different studies indicates no scale demonstrated superior sensitivity, specificity, PPV, or NPV. Additionally, studies investigating stroke and LVO scales in the time and resourced stressed prehospital setting are lacking. Succinctly, there is no ideal or superior stroke instrument for EMS providers. Apropos, VAN was vetted in a single center trial in an ED, not in a prehospital setting. The decision to use VAN as the LVO scale in this QI project reflects the preferences of the majority of stakeholders. Feedback from EMS providers on the utility of VAN in their setting was generally favorable. Specificity, sensitivity, PPV, and NPV of VAN for LVO is an area for future research.

This project demonstrated an interdisciplinary and interagency effort to address quality issues for the high value condition of acute stroke in a rural pre-hospital setting with both volunteer and professional EMS agencies. This was accomplished through the novel application of the role of the Doctor of Nursing Practice (DNP) as a system leader for quality improvement and system think and interprofessional collaboration for improving patient outcomes as outlined by The American Association of Colleges of Nursing (2006). Similar efforts to correlating EMS assessment with hospital response are crucial to compliance with AHA guidelines as set forth in *Mission: Lifeline ® Stroke* and *Target^{sm}: Stroke* and are in the scope of the DNP.

Conclusion

The aim of this QI project was to increase the percentage of stroke pre-alerts and improve door to alert, door to team, door to CT, and door to needle times by adding the VAN scale to EMS assessment, report, and handoff of stroke patients. Statistical significance was observed for increased percentages of pre-alert for Agency A; who eagerly adopted VAN into their practice. Clinical significance was achieved for the dependent variables of pre-alert, door to alert, and door to team. Exploded analysis of the agencies in the samples suggests there is a relationship between increased stroke scale reported through MEDCOM and increased stroke pre-alert. Although not statistically significantly in aggregate data, these improvements can be remarkable in terms of quality patient care and quality outcomes.

Projects that bridge current research and AHA best practice guidance to use vetted LVO instruments in the prehospital setting and to triage stroke patients and activate CSC stroke response based on EMS reports are sparse. While opportunities for improvement still exist, this QI project enhanced quality stroke metrics after clinicians were trained and elements of VAN assessments were observed in patient records. This correlation should not be dismissed and should serve as a guidepost for future prehospital and stroke alert QI projects.

Implications

This QI project helped align prehospital stroke protocols in the service area with AHA national best-practice guidelines as outlined in Mission: Lifeline® Stroke by adding a vetted LVO instrument to EMS stroke assessment and reporting protocols. Further, the project standardizes report & handoff between EMS providers, MEDCOM dispatcher, and ED nursing staff by using the language of the VAN scale and subscales.

Sustainability of Changes

As this manuscript is being written, the ED and stroke team are implementing new stroke alert guidance that uses the VAN scale to qualify stroke alerts beyond six-hours time last normal for a stroke alert. VAN will be available to ED clinicians as a drop-down menu in their EHR as part of this change. Agency C has incorporated VAN as a part of their stroke protocol. MEDCOM is also rewriting their charting program and will include drop-down menus with CPSS and VAN to record EMS stroke reports. Two other EMS agencies in the service area have added VAN as the LVO assessment tool in their stroke assessment protocols. VAN training material from this QI project continues to be disseminated by EMS leaders throughout service area.

Products of the Scholarly Practice Project

Products of this scholarly work include an updated EMS stroke assessment guideline that reflects best practice guidance from the AHA, an updated MEDCOM stroke response protocol, and standard work for ED nurses. Poster presentations of this project have been accepted at professional conferences hosted by the Virginia Association of Clinical Nurse Specialists and at the American Association of Neurological Nurses. A manuscript will be submitted to the Journal of the Emergency Nurses Association and the Journal of Emergency Medical Services.

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Tables

Table 1

Demographic & Operational Data of EMS Transported Stroke Patients

	Year 1	Year 2	*p*
Age[a]	*n*=38	*n*=68	.522
Mean	64.3	65.8	
Median	70.0	69.0	
SD	12.3	10.3	
Range	55.0	40.0	
	n (%)	*n(%)*	χ^2; *df*(*p*)
Gender			0.44; 1(.506)
Male	21(55.3)	33 (48.5)	
Female	17(44.7)	35 (51.5)	
Race			0.00; 1(.960)
White	27(71.1)	48(70.6)	
non-White	11(28.9)	20(29.4)	
Transporting Agency			5.48; 2(.064)
Agency A	13(34.2)	12(17.6)	
Agency C[b]	9(23.7)	12(17.6)	
Other[c]	16(42.1)	44(64.7)	

[a]Age > 75 years old recorded as 75 years old for privacy

[b]Agency C = Agency B and C combined for analysis

[c] *Other* = EMS agencies transporting to the academic medical center that did not participate in VAN training.

Table 2

Percent of Strokes Reported by EMS Agency through MEDCOM and Stroke Pre-Alert by Agency

	Year 1		Year 2		
	Yes n (%)	No n (%)	Yes n (%)	No n (%)	*p*
Stroke Scale through MEDCOM					
Agency A[a]	6(46.2)	7(53.8)	10(83.3)	2(16.7)	.097
Agency C[a]	4(44.4)	5(55.6)	9(75.0)	3(25.0)	.203
Other	9(56.3)	7(43.8)	20(47.6)	22(52.4)	.557
Stroke Pre-Alert					
Agency A[a]	2(15.4)	11(84.6)	8(66.7)	4(33.3)	.015
Agency C[b]	1(11.1)	8(88.9)	4(33.3)	8(66.7)	.338
Other	6(37.5)	10(62.5)	17(38.6)	27(61.4)	.936

[a] Fisher's Exact test used when cells had values <5

[b]Agency C = Agency B and C combined for analysis

Table 3

Scale Reported through MEDCOM & Stroke Alert

	Year 1	Year 2	
	n (%)	n (%)	χ^2; *df* (*p*)
Stroke Scale through MEDCOM[a]	*n*=38	n=66	0.81; 1(.369)
Yes	19(50.0)	39(59.1)	
No	19(50.0)	27(40.9)	
Stroke Pre-Alert	*n*=38	*n*=68	3.81; 1(.051)
Yes	9(23.7)	29(42.6)	
No	29(76.3)	39(57.4)	

[a] MEDCOM = Medical Communication Center

Table 4:

Descriptive Analysis Emergency Department Stroke Quality Care Metrics

	Year 1	Year 2	
	[HR]:MIN:SEC	[HR]:MIN:SEC	p^a
Door to Alert	*n*=29	*n*=45	.182
M	20:31	14:22	
Mdn	11:00	9:00	
SD	24:18	15:51	
IQR[b]	20:30	15:00	
Kurtosis[c]	8.68	7.03	
Skewness	3.16	1.998	
Door to Team	*n*=37	*n*=68	.207
M	17:45	11:54	
Mdn	9:30	6:30	
SD	23:36	15:14	
IQR	25:30	15:15	
Kurtosis	10.51	10.01	
Skewness	2.56	2.12	
Door to CT	*n*=38	*n*=68	.660
M	25:45	29:25	
Mdn	20:00	22:00	
SD	17:14	26:41	
IQR	17:30	19.45	
Kurtosis	3.57	35.79	
Skewness	1.61	3.75	
Door to Needle	*n*=7	*n*=4	.164
M	44:00	1:15:30	
Mdn	44:00	1:13:00	
SD	15:20	38:55	
IQR	26:00	1:15:00	
Kurtosis	-.99	-.79	
Skewness	.13	.27	

[a] Mann-Whitney U test used to compare means

[b] IQR = interquartile range

[c] Kurstosis = kurtosis/standard error

Figures

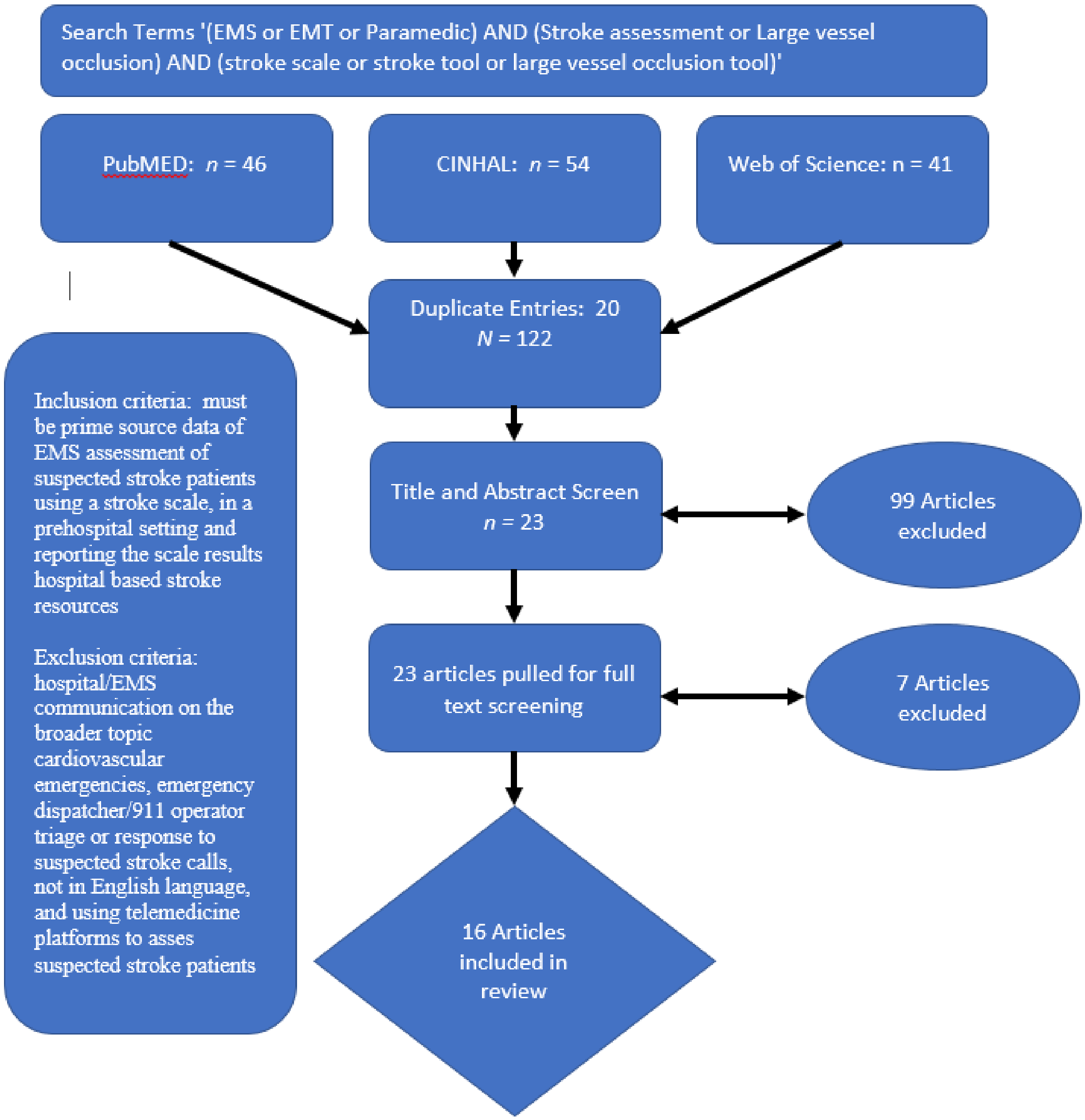


Figure 1. PRISMA diagram of literature selection process.

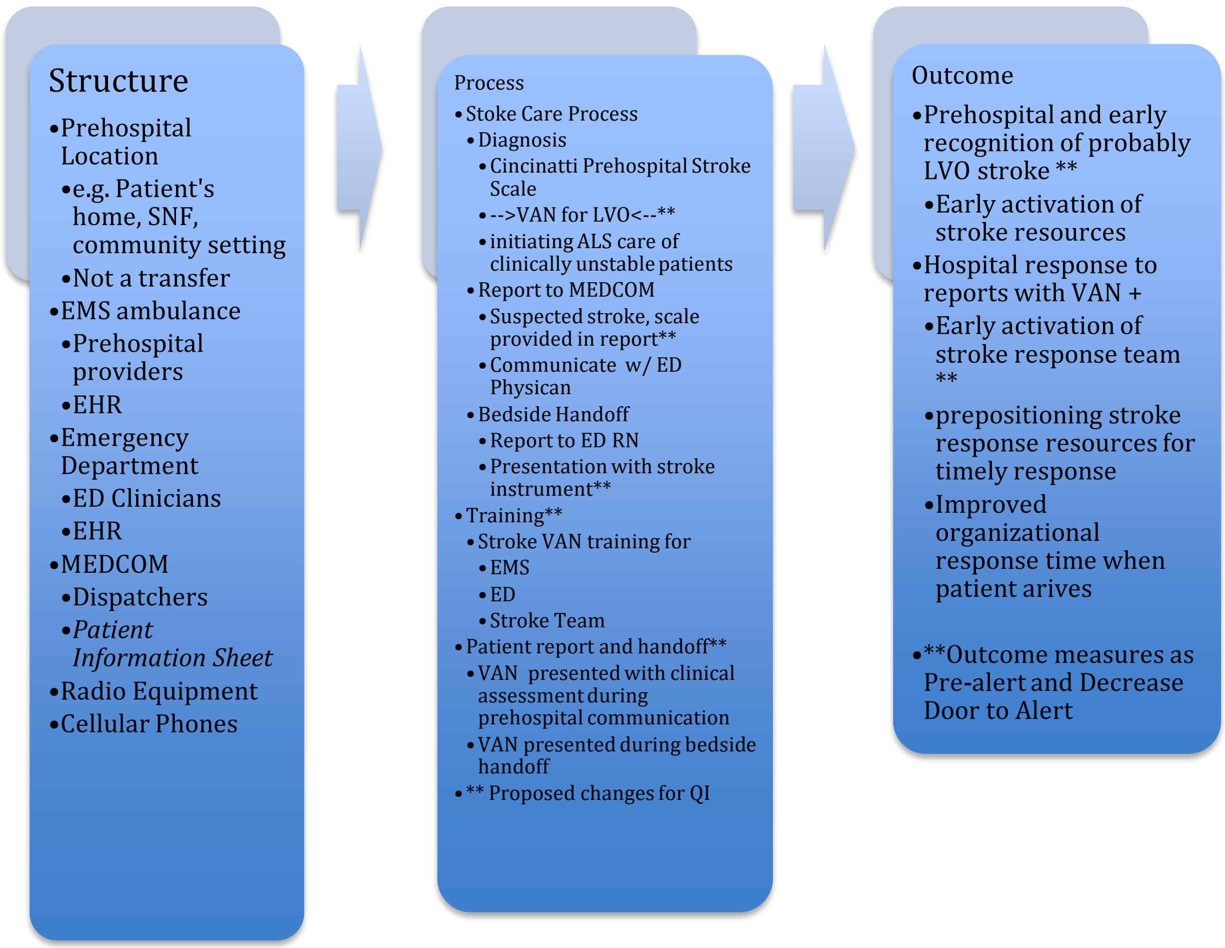


Figure 2. Quality Improvement Project in Donabedian Theoretical Framework of Structure-Process-Outcome

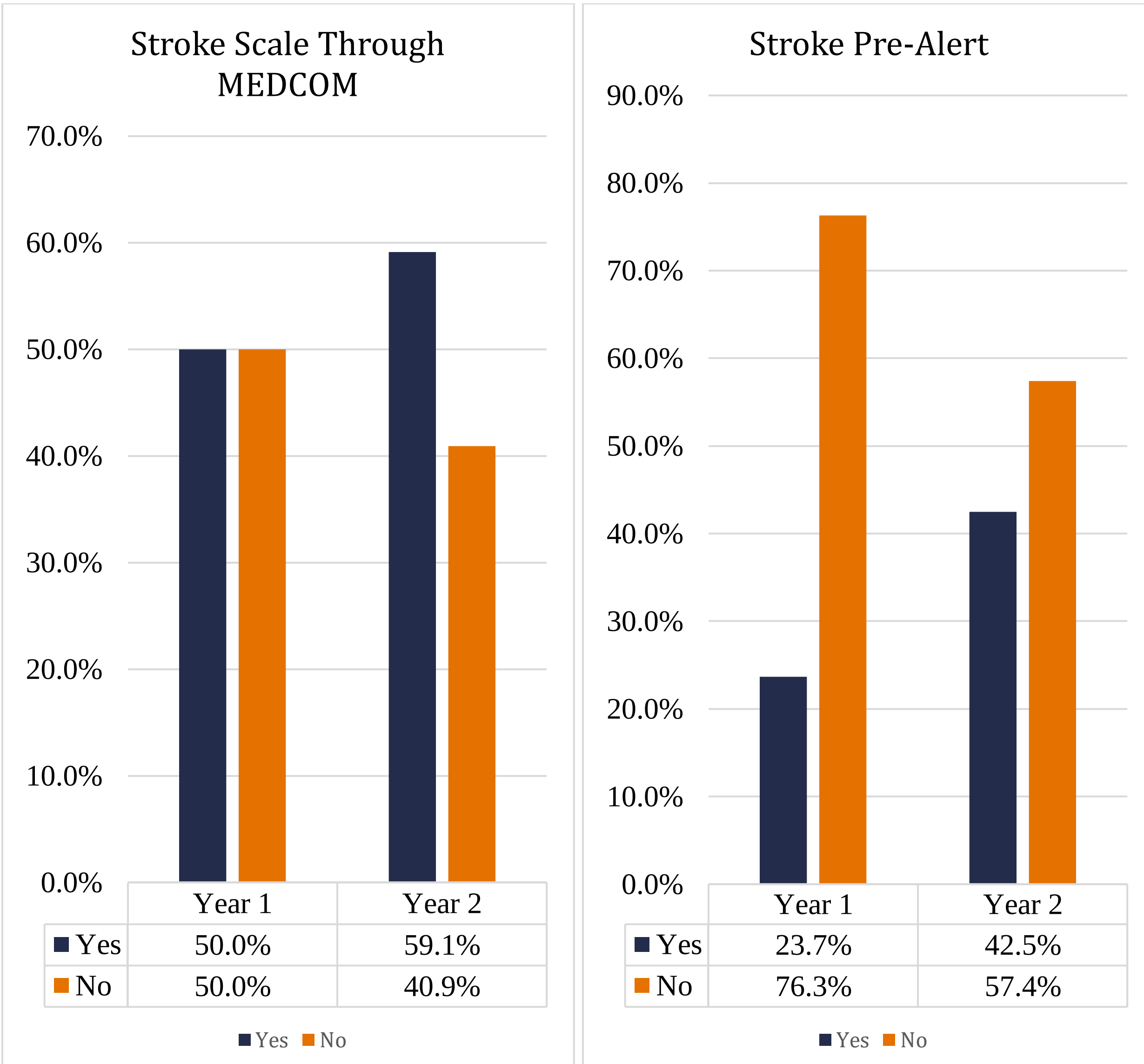


Figure 3. Comparison of Percentages of Stroke Scale to MEDCOM and Pre-alert.

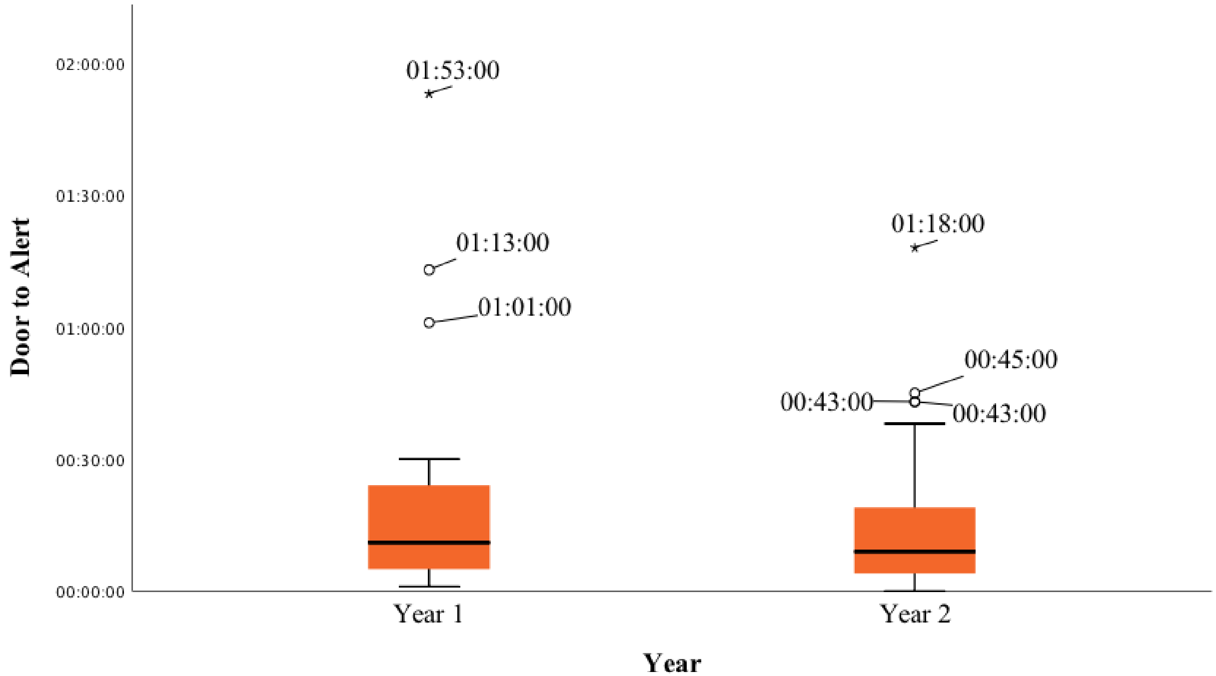


Figure 4. Door to alert time boxplot comparison demonstrating non-parametric distribution of data.

The more compact box in year two represents a smaller interquartile range (IQR). The more compact characteristic of the IQR and kurtosis helps statistically explain mean door to alert times decreased despite the outliers.

Note. Time = [hh]:mm:ss. '°'mild outliers = IQR x 1.5. '*' extreme outliers = IQR x 3.

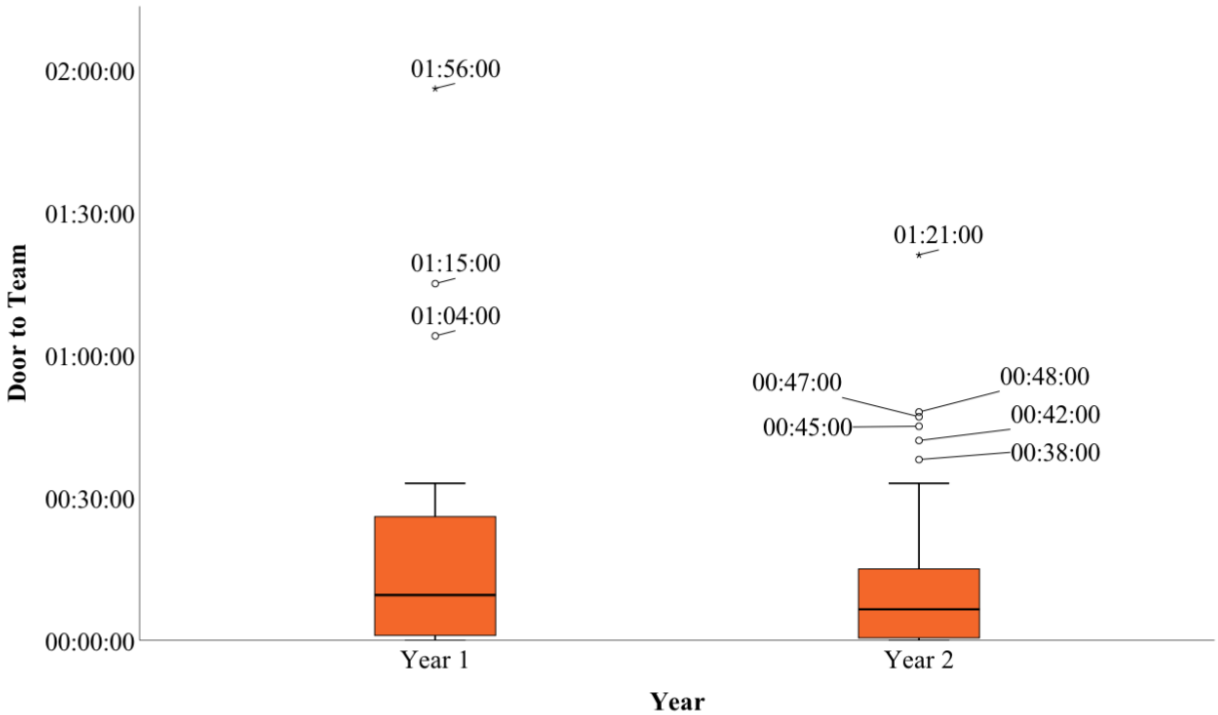


Figure 5. Door to team arrival boxplot comparison demonstrating non-parametric distribution of data.

The more compact box in year two represents a smaller interquartile range (IQR). The compact characteristic of the IQR and kurtosis helps statistically explain why mean door to team times decreased despite the outliers.

Note. Time = [hh]:mm:ss. '°' IQR x 1.5. '*' extreme outliers = IQR x 3.

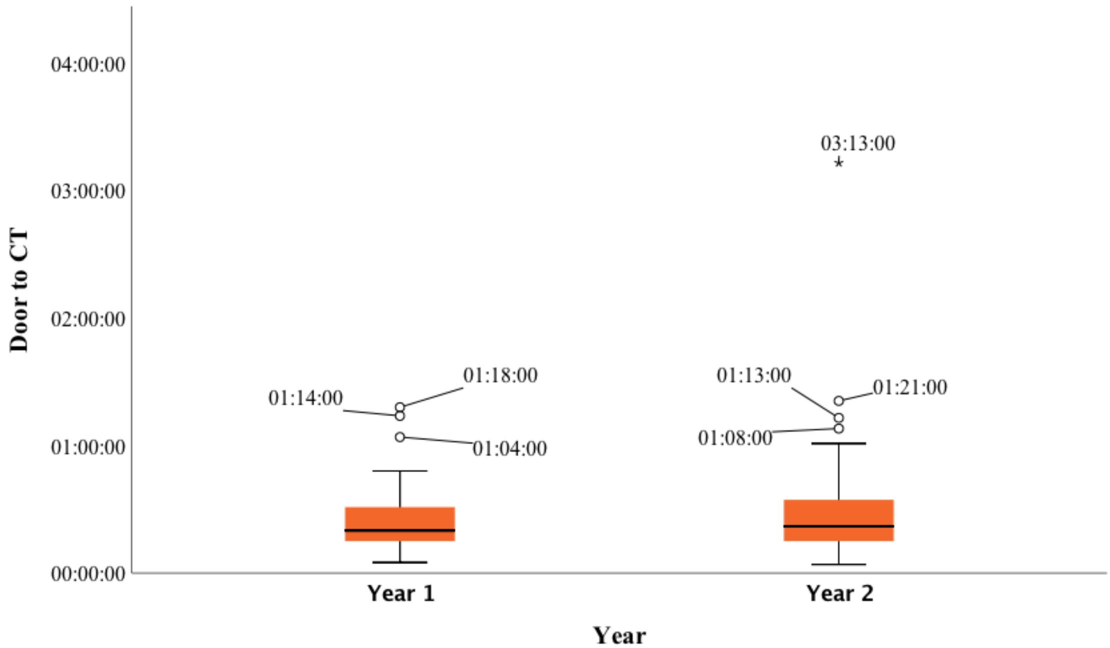


Figure 6. Door to CT times boxplot comparison demonstrating non-parametric distribution of data.

The extreme outlier in year two contributed to the increase in the mean. The encounter that was the extreme outlier in year 1's previous metrics was removed because a CT scan was not clinically indicated. The similar shapes of the data as represented by the box and whiskers supports a conclusion that the increased mean time in year 2 is not clinically significant.

Note. Time = [hh]:mm:ss. '°'mild outliers = interquartile range (IQR) x 1.5. '*' extreme outliers = IQR x 3.

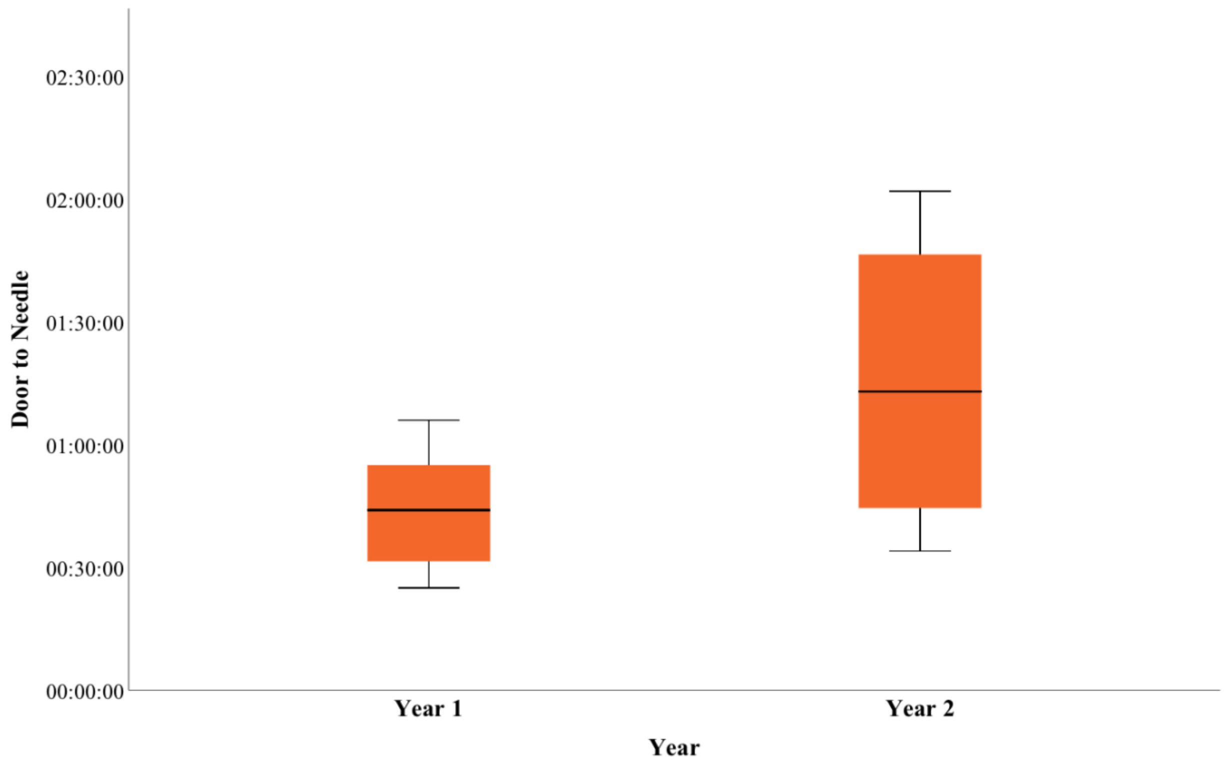


Figure 7. Door to needle time boxplot comparison.

While a more symmetrical shape is observed, both samples in this metric were < 10 and did not meet assumptions of normalcy. Further, the median line correlates well with the increased mean that was observed between the two samples.

Note. Time = [hh]:mm:ss.

Appendix

Appendix A: Scoped Literature Review

Reference and study design	Aim, Subjects & Setting/ Period of Data collection	Outcomes based on stated aims	Limitations
Althubatly et al. (2013) Assessment of the experience of Saudi emergency medical services personnel with acute stroke On-scene stroke identification, triaging, and dispatch of acute stroke patients Cross-sectional qualitative survey	"To assess the knowledge, experience, and the impact of seniority of Saudi EMS personnel in dealing with acute stroke patients." 102 EMS personnel in Riyadh, Kingdom of Saudi Arabia between October and December 2011.	• About half the group has up to 2-years experience • 6% of participants were not aware of any stroke symptoms, 3% identified 5 or more correct symptoms. • None used a stroke assessment Instrument • 98% dispatched to nearest hospital without consideration of stroke treatment capabilities • 6% now about the use of TPA and the time window for use	Small homogeneous sample. Variation in EMS training standards between agencies Nonexperimental design
Smith et al. (2018) Accuracy of Prediction Instruments for Diagnosing Large Vessel Occlusion in Individuals With Suspected Stroke A Systematic Review for the 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Systematic Review with meta-analysis	"What is the diagnostic accuracy of LVO prediction instruments for identifying LVO in individuals with suspected stroke or confirmed to have acute ischemic stroke in the prehospital or hospital emergency room settings?" Evidence Review Committee of the American Heart Association searched Medline, Cochrane Central Database of Controlled Trials, & Embaseon October 27, 2016, 36 trials were reviewed	• 4 studies where an LVO instrument was used by EMS • Instruments were NIHSS, Cincinnati Prehospital Stroke Screen, Los • Angeles Motor Scale (LAMS), Los Angeles Prehospital Stroke Screen, and Rapid Arterial Occlusion Evaluation (RACE). • 2 studies included suspected stroke • Patients • 2 included only patients who were diagnosed with ischemic stroke.	Only 4 studies in an EMS Setting Some articles were only in abstract without formal printing in a peer reviewed journal by April 1, 2017 Some studies did not precisely define the denominator population

Appendix A: Scoped Literature Review

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Kesinger et al. (2014) Comparing National Institutes of Health Stroke Scale Among a Stroke Team and Helicopter Emergency Medical Service Providers Prospective observational study	"This study aimed to determine the agreement between HEMS and stroke team providers using the NIHSS and the ability to predict LVO." Setting: Patients flown in a helicopter to a comprehensive stroke center; an urban academic medical center. Time: not well defined. Neither is clear index of observation (e.g. a desired *n*).	• At NIHSS≥12, HEMS had a positive predictive value of 80.5% (sensitivity, 51.9%; specificity, 87.4%), and stroke team had a PPV of 88.5% (sensitivity, 48.6%; specificity, 93.7%). • HEMSs and stroke teams had similar results in their ability to predict LVO (receiver operating curve area under curve, 0.768 and 0.770, respectively)	Only looked at acute ischemic stroke Not experimental in design Time window for intervention has changed now Poorly defined timeline of data collection
Purrucker, et al. (2017) Design and validation of a clinical scale for prehospital stroke recognition, severity grading and prediction of large vessel occlusion: the shortened NIH Stroke Scale for emergency medical services Non-randomized clinical study	"Our aim was to allow for parallel stroke recognition, severity grading and—owing to full NIHSS compatibility—progression monitoring as well as LVO prediction." Data collection: between November 2007 and August 2010 Scale development through German, Switzerland, & Austria Scale testing: Heidelberg, Germany	• ROC analysis of the sNIHSS-EMS regarding LVO prediction revealed a maximal Youden index at the cut-point of ≥6 (sensitivity 70.3% (95% CI 64.7 to 75.5), specificity 80.7% (95% CI 76.8 to 84.3)) • No statistically significant differences compared with existing scales were found, except for the full-length NIHSS, and the sNIHSS-8.	Excluded gaze preference from the Instrument. Test cohort only included patients with a diagnosis of ischemic stroke German EMS system includes physicians in the ambulance, limiting applicability and potential bias. Scale was developed based on a survey through a professional organization Single center design

Appendix A: Scoped Literature Review

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Pérez de la Ossa, et al. (2013) Design and Validation of a Prehospital Stroke Scale to Predict Large Arterial Occlusion The Rapid Arterial Occlusion Evaluation Scale Two phase retrospective cohort analysis and Prospective non-randomized clinical trial	"The objective of this study was to evaluate the predictive value of the Rapid Arterial oCclusion Evaluation (RACE) scale on the detection of patients with acute stroke and LVO when used by medical emergency technicians during the prehospital phase." Setting: Prehospital community-based EMS in Spain transporting to a CSC Time: January 2006 to March 2010	• Retrospective: RACE showed a similar positive predictive value to the NIHSS (area under the curve, 0.81 versus 0.80). Correlation between RACE and NIHSS scores was 0.93 (*P*<0.001). • Prospective data: A strong correlation was observed between the RACE scale assessed by medical EMT before hospital arrival and the NIHSS assessed by neurologist at admission (*r*=0.76; *P*<0.001). • RACE scale was comparable with NIHSS to predict LVO (c-statistic, 0.85; 95% CI, 0.81–0.89).	Only 60% of patients transported for suspected stroke made the final cohort in prospective analysis. Potential for bias in favor of LVO Diagnosis of LVO was made with something other than CT/CTA Single center non-randomized design has a potential for bias
Lin et al. (2012) Emergency Medical Service Hospital Prenotification Is Associated With Improved Evaluation and Treatment of Acute Ischemic Stroke Non-experimental Retrospective analysis	"…our study goals were to evaluate the association of EMS prenotification with acute ischemic stroke evaluation and treatment, including door-to-imaging times, door-to–needle times, onset-to–door times, and rates of tPA treatment in eligible patients." Setting: Data was pulled from hospitals participating in GWTG Timing: 2003-2011	• EMS prenotification happened about 67% of the time • Prenotification rate 72% when TLN < 2 hours • When adjusted for use of the NIHSS, rates showed modest improvement. • Generally, prenotification is underused • NIHSS use did not improve performance	GWTG is voluntary and my and may be bias for high performance and improving organization Relevant data may be missing for database (e.g. a prenotification) Potential for selection bias because organization are recognized for tiered performance Retrospective study design

Appendix A. Scoped Literature Review

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Spencer et al. (2009) Emergency Medical Services Support for Acute Ischemic Stroke Patients Receiving Thrombolysis at a Primary Stroke Center Non-Experimental Retrospective analysis	"…purpose was to evaluate the EMS component of thrombolysed acute ischemic stroke patient care at a primary stroke center (PCS)." Setting: A primary stroke center in urban south west. Time: September 2001 to August 2005	• 81% of the acute stroke patients treated at the PSC were brought in by EMS • Cincinnati Prehospital Stroke scale was used 100% of the time • 88% of the EMS transported cases with clinical suspicion of stroke were acute ischemic stroke. • Generally, EMS plays a vital role in the stroke chain of survival	Non-experimental descriptive study only Small sample in a homogeneous population
Kim et al. (2017) Field Validation of the Los Angeles Motor Scale as a Tool for Paramedic Assessment of Stroke Severity Prospective randomized clinical trial	"…prospectively assessed the performance characteristics of the Los Angeles Motor Scale (LAMS) performed in the field by paramedics at multiple sites in a large and diverse geographic region." Setting: Orange and Los Angeles Counties California Date: 2004-20012	• LAMS correlated very strongly with the concurrently performed NIHSS in ischemic stroke patients (r=0.89), intracranial hemorrhage patients (r=0.81), and all ACVD patients (r=0.89) • Correlations of the LAMS and Glasgow coma scales were weak when concurrently performed in the field on acute ischemic stroke patients (r=−0.27), intracranial hemorrhage patients (r=−0.09), and acute cerebrovascular disease patients (r=−0.2) • Study provides validation of the LAMS as a Instrument for paramedics to assess stroke severity.	Study excluded patients with preexisting cerebrovascular disease The comparison NIHSS data were collected on average 83 minutes after ED arrival Early vessel imaging were not obtained routinely While a multicenter in design, it was conducted in a single region.

Appendix A. Scoped Literature Review

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Asimos et al. (2014) Out-of-Hospital Stroke Screen Accuracy in a State With an Emergency Medical Services Protocol for Routing Patients to Acute Stroke Centers Retrospective analysis	"The purpose of this study was to conduct a statewide assessment of the accuracy of the Cincinnati Prehospital Stroke Scale (CPSS) and Los Angeles Prehospital Stroke Scale (LAPSS) in identifying stroke patients by comparing the stroke screen results in statewide hospital database with the ED diagnostic information contained in an EMS state database." Setting: North Carolina Time: January 2009 – March 2011	• The CPSS - sensitivity of 80% (95% CI 77% to 83%); specificity of 48% (95% CI 44% to 52%) • The LAPSS - sensitivity of 74% (95% CI 71% to 77%); specificity of 48% (95% CI 43% to 53% • Both scales showed improved sensitivity when ICD-9 codes for TIA were excluded • Worst-case scenario, the sensitivities of the CPSS and LAPSS decreased to 69% (95% CI 66% to 73%) and 65% (95% CI 61% to 68%), respectively, whereas the specificities decrease to 35% (95% CI 31% to 39%) and 30% (95% CI 26% to 35%)	This is a non-experimental study design There is a potential for bias because ICD-9 codes were missing in the study sample The inclusion criteria favor oversensitivity The databases relied on ED diagnosis of stroke. This meant inpatient diagnostics and final diagnosis codes were missed.
Demeestere et al. (2016) Validation of the National Institutes of Health Stroke Scale-8 to Detect Large Vessel Occlusion in Ischemic Stroke Retrospective non-experimental evaluation of data	"…aimed to assess the accuracy … National Institutes of Health Stroke Scale-8 (NIHSS-8) for identification of patients with LVO, to validate the scale in a general cohort of patients suspected with acute ischemic stroke assessed by EMS, and to test the inter-rater reliability of the NIHSS-8 between the EMS and the hospital stroke team." Setting: EMS Australia Time: 2012-2016	• The median NIHSS-8 of patients suspected with acute ischemic stroke (N = 551) was 5 (IQR 2-10) • VO patients (n = 136) had a median NIHSS-8 score of 11 (IQR 8-14) • There was a significant difference between the median NIHSS-8 score of patients with an LVO (n = 136) and patients without an LVO (n = 415), who had a median NIHSS-8 of 4 (IQR 2-7; *P* value for difference < .0001) EMS and the hospital stroke team reached substantial agreement on NIHSS-8 rating, with an overall linear- weighted Cohen's kappa of .69. T	A substantial proportion of stroke patients with an LVO would remain undetected (15%-20%)…this is similar to other scales Retrospective study design does not address the paradigm of EMS and stroke activation à activate when suspicious Not all subscales demonstrated interrater reliability

Appendix A. Scoped Literature Review

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Studneck et al. (2013) Assessing the Validity of the Cincinnati Prehospital Stroke Scale and the Medic Prehospital Assessment for Code Stroke in an Urban Emergency Medical Service Agency Prospective quasi-experimental clinical trial	"(aimed) to assess the effectiveness in the prehospital setting of the CPSS and the Med PACS in correctly classify patients suspected of having a stroke. A secondary analysis was performed to compare the differences in the sensitivity and specificity of the two screening Instruments in patients experiencing signs and symptoms of acute stroke." Time: March 1, 2011-September 30, 2011 Setting: Urban North Carolina	• The Med PACS scale demonstrated a sensitivity of 0.742 (95% CI 0.672–0.802), while the sensitivity for the CPSS was 0.790 (95% CI 0.723–0.845). • The NPV of these scales for stroke stroke, expressed as specificity, was low: Med PACS 0.326 (95% CI 0.267–0.391) vs. CPSS 0.239 (95% CI 0.187–0.300). • Sensitivity of the CPSS was significantly higher than that of the Med PACS, with the difference being 0.048 (95% CI 0.009–0.088), p = 0.011. • The CPSS is more useful in an Urban area	Urban setting where all hospitals were TPA capable is not the same as rural and suburban settings where not all hospitals have the same stroke response capabilities Retrospective design is non-experimental à EMS not informed but were taught to document during annual training Exclusion for missing data when screened negative may enter bias
Richards et al. (2018) Cincinnati Prehospital Stroke Scale Can Identify Large Vessel Occlusion Stroke Retrospective analysis nested in a larger study	"We hypothesize that a cut-off score of the Cincinnati Prehospital Stroke Scale (CPSS), …, can be used to identify LVO." Setting: A single EMS agency reporting to a single CSC in an urban area Time: August 2012 and April 2014	• The optimal CPSS score to predict LVO was 3, sensitivity of 0.41, and a specificity of 0.88 • The unadjusted OR for the presence of LVO for patients with CPSS = 3 was 5.1 (95% CI 2.1–12.2). • The optimal CPSS cut-off score to predict reperfusion therapy was 2 among patients who arrived with a last known well time of 270 minutes. • The unadjusted OR for reperfusion therapy in patients with CPSS = 3 and last known well time of 270 minutes was 13.1 (95% CI 4.6–37.0).	This is a study at a single center and the results may not translate into other system or regions CTA was not always performed prior to TPA, some LVO may have been missed Final population only included those diagnosed with AIS

Appendix A. Scoped Literature Review

Reference and study design	Aim, Subjects & Setting/ Period of Data collection	Outcomes based on stated aims	Limitations
Gropen et al. (2014) Factors Related to the Sensitivity of Emergency Medical Service Impression of Stroke Retrospective analysis of EMS run sheets and hospital records	"Aimed to examine factors related to sensitivity of emergency medical services (EMS) stroke impression." Setting: Long Island Community Hospital. An urban hospital in Brooklyn NY USA Time: January 1, 2009 and January 1, 2011	• 28/56 (50%) of strokes were missed by EMS (false negatives) and 9/254 (3.5%) were falsely considered to have stroke by EMS (false positives) • EMS diagnostic sensitivity - 50% (95% CI: 36–64%) and specificity - 96% (95% CI: 93–98%). • Varied reasons for false positives. No EMS impression was documented in 10/28 (36%) of the false-negative patients. • EMS exclusion of stroke is poor	Retrospective study design Missing data in about 1/3 of false negative Bias for over diagnosis to achieve sensitivity.
Hodell et al. (2016) Paramedic Perspectives on Barriers to Prehospital Acute Stroke Recognition Qualitative cross-sectional cohort	"Aimed to understand prehospital providers' perspectives on obstacles to stroke recognition and opportunities for improvement, to identify areas for future research, and strengthen the body of evidence on which to ultimately devise interventions that would augment prehospital stroke recognition and advanced notification." Setting: 12 EMS agencies in California N = 128 Time: No clearly stated	• Group described diagnostic challenges of stroke in terms of "so many types" and "lack or equipment like a CT scanner" • They described structural challenges such as lack of follow up and rapport with physicians (although they felt they had a rapport with nurses) • Scales were less likely to be used by newer medics who tended to rule out stroke earlier than seasoned medics Reported that drop down menus did not effectively convey what they were seeing. So charting did not reflect report	A small homogeneous sample that lacked diversity from one state A convenience sample assigned by EMS leaders at the agencies may lend to bias

Appendix A. Scoped Literature Review

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
McMullen et al. (2017) Prospective Prehospital Evaluation of the Cincinnati Stroke Triage Assessment Tool Prospective non-randomized clinical trial	"…(aimed) to describe the feasibility of prehospital implementation of the Cincinnati Stroke Triage Assessment Tool (C-STAT) to identify subjects with severe stroke (NIHSS ≥ 15)… we evaluated the ability for the tool to identify subjects with NIHSS □10, the presence of LVO" Time: June–November 2015 Setting: Cincinnati Fire EMS	• NIHSS≥15, C-STAT had a sensitivity of 77% (95% CI 46–95); specificity of 84% (95% CI 69–93) • NIHSS≥10, the sensitivity of C-STAT was 64% (95% CI 41–83); specificity 91% (95% CI 76–98). • Presence of LVO, sensitivity 71% (95% CI 29–96); specificity 70% (95% CI 55–83 • C-STAT was not able to be scored in 19/131 (14%) of FAST-positive subjects,	No change to stroke triage protocol. Only evaluated the Instrument in the prehospital setting pilot study is the small sample size and resulting wide confidence intervals around the measured test characteristics A single center in an urban area Minimal training of EMS personnel

Appendix A. Scoped Literature Review

Relevant literature not meeting search criteria

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Toled et al. (2016) Stroke vision, aphasia, neglect (VAN) assessment—a novel emergent large vessel occlusion screening tool: pilot study and comparison with current clinical severity indices Quasi experimental nonrandomized clinical trial	"We tested the ability of VAN to identify LVO patients presenting to our center and compared it with an NIHSS threshold of ≥6" Setting: Southwest US Time: Not well defined *N* = 62	• VAN is 100% sensitivity • 5 VAN positive patients were found to not harbor an ELVO (90% specificity) with 80% (4/5) being stroke mimics. • Interobserver reliability was 100% • VAN screen performed in 15 sec	Not in an EMS setting A single center study No control group
Wang et al. (2017) Streamlining Workflow for Endovascular Mechanical Thrombectomy: Lessons Learned from a Comprehensive Stroke Center Systemic Literature Review	"…this review aims to detail the optimal workflow of treatment of patients with acute ischemic stroke at a single comprehensive stroke center." Setting: N/A	• Phase 1 of care clearly outlines the importance of EMS communication of patient status to either ED physician or charge nurse AND activation of the inpatient stroke team • Inpatient stroke team generally arrives to the ED before the patient to facilitate smooth transition of care • Alert goes to ED staff, Stroke team, & Radiology staff. • ED and Stroke team meet patient at door, transfer directly to CT if hemodynamically stable	A scoped literature review without meta-analysis of actions in the phases Single database accessed for literature

Appendix A. Scoped Literature Review

Relevant literature not meeting search criteria

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Najafi et al. (2017) Perspectives of Patient Handover among Paramedics and Emergency Department Members; a Qualitative Study Qualitative Study with inductive content analysis	"the present study aimed to explore the perspectives of paramedics and ED members regarding patient handover." Setting: Single Hospital in an urban area, EMS and ED personnel with minimum 2-years experience Time: collected in 2015	• Extrinsic factors: different perceptions about environment, equipment available on the ambulance Intrinsic factors: different perceptions about recruiting and manpower, and "nurses expect us to handoff and participate in the care while manager expect us to get back to our units in 10 minutes	Single Center Study Homogenous sample May not share cultural elements with the targeted staff in this study
Meisel et al. (2015) Optimizing the Patient Handoff Between Emergency Medical Services and the Emergency Department Mixed method analysis of cohort	"The purpose of this study was to identify issues and factors surrounding the EMS handoff process to build a picture of how the EMS-to-ED handoff functions and how it can be improved to translate into safer, more efficient, and higher-quality patient care." Convenience sample of EMTs recruited at three national and regional conferences. Time: January to March 2011	• Handoffs are a central feature of their work • They lack standard format or location for handoff • Identified a perceived hierarchy of patient acuity (trauma garnered the most attention) Identified a perceived hierarchy of clinicians (Trauma surgeons at the top)	Convenience sample Smaller sample (*N* =48) The data are hypothesis generating by design Some participants were reported to possess multiple credentials (MD and EMT) (*n* = 13)

Appendix A. Scoped Literature Review

Relevant literature not meeting search criteria

Reference and study design	**Aim, Subjects & Setting/ Period of Data collection**	**Outcomes based on stated aims**	**Limitations**
Benoit et al. (2018) Prehospital Triage of Acute Ischemic Stroke Patients to an Intravenous tPA-Ready versus Endovascular-Ready Hospital: A Decision Analysis A model development based on retrospective data from several data sources and literature review	"To provide better guidance to EMS providers, we sought to evaluate different prehospital transportation triage strategies for acute ischemic stroke and determine which variables affect patient outcomes." Setting: The population-based Greater Cincinnati/Northern Kentucky Stroke Study dataset; SITS-ISTR is a multinational, open registry of consecutive acute ischemic stroke patients who received reperfusion therapies at 132 centers Time: Not well defined	• Transporting to endovascular ready hospitals (ERH) demonstrative variable optimal times intervals when risk for LVO was high. • If the risk for LVO is assessed with a scale, and the risk is low, transport favors TPA ready hospital • Increasing sensitivity of the scale diminishes utility of the scale data Model suggests that harm may result from both false positives (LVO negative patient who is triaged to ERH and receives late IVT) and false negatives (LVO positive patient triaged to IRH who receives late EVT)	Model assumes standardize performance in door to needle time for TPA and rate of revascularization at ERH Missed strokes and patients misdiagnosed with stroke were also not evaluated. Missed strokes would likely be transported to the closest hospital. Model does not account for data from the DAWN trial.
Milne et al. (2009) Drip 'n Ship Versus Mothership for Endovascular Treatment: Modeling the Best Transportation Options for Optimal Outcomes Modeling through mapping and probability calculations	"A key question is whether average benefit is greater with early thrombolysis at the closest PSC before transportation to the CSC (Drip 'n Ship) or with PSC bypass and direct transport to the CSC (Mothership)." Setting and time not applicable Used data form Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT to Recanalization Times (ESCAPE) trial to develop the model.	Dip 'n' Ship is superior provided the PSC is able to administer TPA in less than 30 minutes and the CSC is not efficient	This is model developed with a large trial. But, it is an untested model. The primary data sources are from the western US and Canada. The model may not catch challenges and variables unique to others areas

Appendix B. Definitions

VAN: vision aphasia neglect. Vision indicates a change to vision or loss of a visual field. Aphasia is unable to speak or unable to follow directions. Neglect is decreased awareness of a side of the body.	LVO: large vessel occlusion. For the purposes of this study, LVO is ischemic stroke syndrome with thrombus formation in the extracranial vessels like the common and internal carotid, and vertebral arteries; and intracranial vessels in Circle of Willis and proximal branches (Caplan, 2018)	OMD: Operational Medical Directors provide medical direction for EMS agencies and MEDCOM. The approve treatment protocols and provide signature authority for said protocols and medications
GWTG: Get With the Guidelines ® is a tiered recognition program managed by the AHA where hospitals voluntarily contribute to a database and are recognized for meeting benchmarked care standards	CSC: Comprehensive Stroke Center as designated by the Joint Commission Disease Specific Recognition Program. It is the highest rating a stroke center can receive.	MEDCOM: Medical Communications Center is located at the hospital and coordinates communication with EMS and ED clinicians
TLN: time last normal is the time the patient was last functioning at their baseline.	EVT: endovascular treatment. A catheter is introduced into a vessel threaded to an occlusion to either stent vessel or perform a thrombectomy.	Hip-pocket Training: Teaching a succinct curriculum in the work environment as time permits and is convenient to the trainer and trainee
Paramedic (medic): Prehospital providers that possess advanced assessment skills. Their scope of practice advanced life support, rapid sequence intubation and administering medication	EMT-B: Emergency Medical Technician – Basic. These prehospital providers can perform a basic assessment and basic lifesaving care like CPR.	EMT-I: Emergency Medical Technician – Intermediate. These providers possess enhanced assessments skills and can administer some medications
Report: For the purposes of this study, EMS prehospital report to the ED at the academic medical center via cell phone or radio devices	Handoff: for the purposes of this study, EMS transfer of care to ED clinicians which includes a bedside patient report	Stroke team pre-alert: stroke response team is notified prior to patient arrival

Appendix B. Definitions

Door to alert time: Time in minutes from when the patient crosses the ED threshold to alerting the stroke response team	Door to Team: Time in minutes from when the patient crosses the ED threshold to the arrival of the first member of the stroke team	Door to CT: Time in minutes from when the patient crosses the ED threshold to the non-contrast CT is read by a member of the stroke team
Door to Needle: Time in minutes from when the patient crosses the ED threshold to the administration of TPA is started. Some literature refers to this metric as door to needle time.	EMS run sheet: an EMS provider generated patient record of their assessment, care, and report to the hospital. This is left with the receiving hospital after hand-off of care. .	

Appendix C. Training Plan

<table>
<tr><th colspan="5">Training Plan in a Logic Model Framework</th></tr>
<tr><th>INPUTS</th><th colspan="3">OUTPUTS</th><th>IMPACT</th></tr>
<tr><th></th><th>Participants/ equipment</th><th>Activities</th><th>Direct Products</th><th>Short Term</th></tr>
<tr><td>Time: ≈ 15 minutes</td><td></td><td rowspan="4">• Hip-Pocket Training
• Huddle/ shift brief
• Faculty meeting
• Rounds
• Station training</td><td rowspan="4">• Training reference card
• Training survey
• VAN assessment in charting
• Training report</td><td rowspan="7">Primary Outcome:
Trend door to Alert of stroke patients
Incidence of stroke pre-alerts for participating EMS agencies</td></tr>
<tr><td>EMS Providers</td><td>• EMT
• Paramedics</td></tr>
<tr><td>ED Clinicians</td><td>• Techs
• Nurses
• NP/PA
• Physicians</td></tr>
<tr><td>Neurology</td><td>Stroke Team</td></tr>
<tr><td>Space</td><td>• Space available during the shift
• Space on Information board</td><td>• Space for training
• Display space</td><td>• Space to display scaffolding literature and progress</td></tr>
<tr><td>Equipment</td><td>• Information board
• EHR Charting
• Cellphone/tablet to display video if desired</td><td>• Display literature and progress of QI project
• Free text comment block for “VAN +/-”</td><td></td></tr>
<tr><td>No capital, just time</td><td></td><td></td><td></td></tr>
</table>

Appendix D. Curriculum Outline

Stroke VAN Curriculum Plan		
Component (Est Time)	**Material Presented**	**Objective**
• What is Stroke VAN? (4 minutes)	• Stroke VAN is LVO Assessment Instrument. ○ It is used in conjunction with your agency/institution stroke scale ○ NIHSS, Cincinnati Prehospital Stroke Scale, BEFAST, etc • What does VAN Stand for ○ **V**isual Disturbance ○ **A**phasia ○ **N**eglect • Why Stroke VAN ○ Stroke is the # 1 cause of disability ○ Large artery strokes are the most disabling ○ VAN allows us to identify these patients early and gives these patient the best possibility of a good outcome	When block is complete, student will be able to: • Define Stroke VAN • Describe why VAN is relevant to prehospital care and communication to the ED
When do you use Stroke VAN (3 minutes)	• Pre-hospital Providers ○ When there is a clinical suspicion of Stroke ○ When reporting patient status to MEDCOM ○ When doing bedside handoff • Hospital Clinicians ○ In practice when there is a clinical suspicion of stroke ○ When receiving report from MEDCOM or EMS in the field. ○ When receiving BEDSIDE report from EMS ○ When communicating patient status to inpatient stroke team	When block is complete, student will be able to: • Describe when to use VAN in their practice

How to assess Stroke VAN (5 minutes)	Assess Stroke VAN instrument after assessing patient for stroke per agency/institution's protocol ● If patient has **any degree of weakness PLUS any one of the below:** ○ **Visual Disturbance** (Assess field cut by testing both sides, 2 fingers right, 1 finger left) ○ **Aphasia** (Inability to speak or understand. Repeat and name 2 objects, close eyes, make fist) ○ **Neglect** (Forced gaze to one side or ignoring one side, touching both sides) **This is likely a large artery clot (cortical symptoms) = VAN Positive** **Teacher will demonstrate how to perform each subtes*t, Students will demonstrate back to instructor or on peer	When block is complete, student will be able to: ● Describe how to perform ● Demonstrate on instructor or peer how to perform each test
How to chart and report findings of VAN instruments (2 minutes)	● Report outcomes of VAN as ○ "VAN +" or "VAN -" ● EMS ○ Include in narrative or free text box with stroke scale ● MEDCOM ○ Free text in comment box of MEDCOM patient report sheet ● ED Clinicians ○ Chart with Triage Note **All that is needed is a VAN +/-. Subscale score is not needed because once they are positive for one aspect, there is not need to test further. This is a screening Instrument, not a diagnostic tool*	When block is complete, student will be able to: ● Describe how to report instrument assessment during report and handover of care ● Chart exam results in their area

Appendix E. Reference Card/Display

Stroke VAN Reference Card
Assessment tool

1. Stroke Screening first

⇒ **Cincinnati Prehospital Stroke Scale**

◊ **Facial Droop, Arm Drift, Abnormal Speech**

If ARM weakness is present – continue to VAN EXAM

Arm Weakness + any VAN positive finding = **POSITIVE VAN SCREEN**	YES	NO
Visual Disturbance? • Field Cut (which side) (4 quad-rants) • Double vision (ask patient and look to right then left, evaluate for uneven eyes) • Blind new onset		
Aphasia? • Expressive (inability to speak or errors) don't count slurring of words (repeat & name 2 objects) • Receptive (not understanding or following commands) (close eyes, make fist) • Mixed		
Neglect? Forced gaze or inability to track to one side Unable to feel both sides at same time, or unable to identify own arm Ignoring one side		

Stroke VAN Reference Card
Reporting prompt

Key Items to report:

⇒ **Vital Signs:**

⇒ **Time last known normal:**

⇒ **Current Medications**

◊ **Coumadin/warfarin**

◊ **Eliquis/apixaban**

◊ **Brilinta/ticagrelor**

◊ **Xarelto/rivaroxaban**

◊ **Predaxa/dabigatran etexilate**

◊ **Lovenox/low molecular weight heparin**

⇒ **Blood Glucose:**

⇒ **Known Seizure Disorder**

Family/Witness Contact Information:

Appendix F. Training Slides

STROKE VAN

Point of Contact for this Presentation is:
Aaron Matthews
MSN, RN, CEN
jam5ad@Virginia.edu

University of Virginia Health System

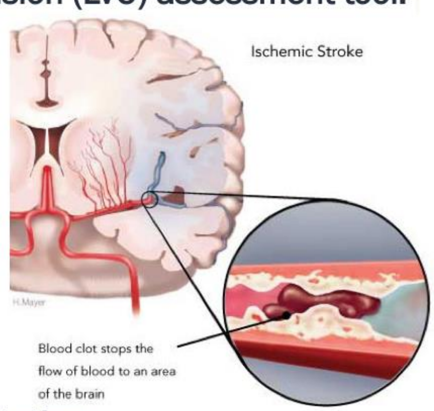
University of Virginia Health System

WHAT IS STROKE VAN?

Stroke VAN is Large Vessel Occlusion (LVO) assessment tool.

VAN Stands for:

- **Vision**
- **Aphasia**
- **Neglect**



Why Stroke VAN?

- Stroke is the #1 of disability
- LVO stroke are the most debilitating
- Stroke VAN identifies these patients early

University of Virginia Health System

WHEN TO USE STROKE VAN

Use Stroke VAN with the Cincinnati Prehospital stroke scale

EMS

- Clinical suspicion of stroke
- Reports and Handover of cares

Hospital Clinicians

- Clinical suspicion of stroke
- Reports and Handover of cares
  - Receiving report from EMS
  - Giving report to Neurology

University of Virginia Health System

HOW TO ASSESS STROKE VAN

If ARM weakness is present – continue to VAN EXAM

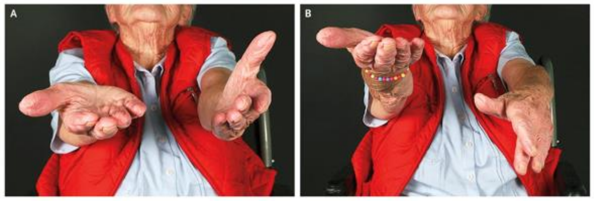
Arm Weakness + any VAN positive finding = POSITIVE VAN SCREEN	YES	NO
Visual Disturbance? • Field Cut (which side) (4 quadrants) • Double vision (ask patient and look to right then left, evaluate for uneven eyes) • Blind new onset		
Aphasia? • Expressive (inability to speak or errors) don't count slurring of words (repeat & name 2 objects) • Receptive (not understanding or following commands) (close eyes, make fist) • Mixed		
Neglect? • Forced gaze or inability to track to one side • Unable to feel both sides at same time, or unable to identify own arm • Ignoring one side		

University of Virginia Health System

Show what you know

HOW TO ASSESS STROKE VAN CONT.

1st: Arm weakness (pronator drift already checked in CPSS)



How many fingers am I holding up?

2nd : Vision; field cuts, double vision or new blindness

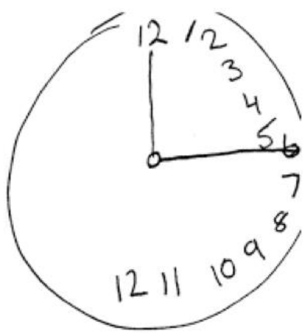
University of Virginia Health System

Show what you know

HOW TO ASSESS STROKE VAN CONT.

3rd: Aphasia; name two objects & follows commands

4th: Neglect; fixed gaze or misses light touch



University of Virginia Health System

HANDOFFS AND CHARTING YOUR ASSESSMENT

The assessment is reported either "VAN +" or "VAN –"

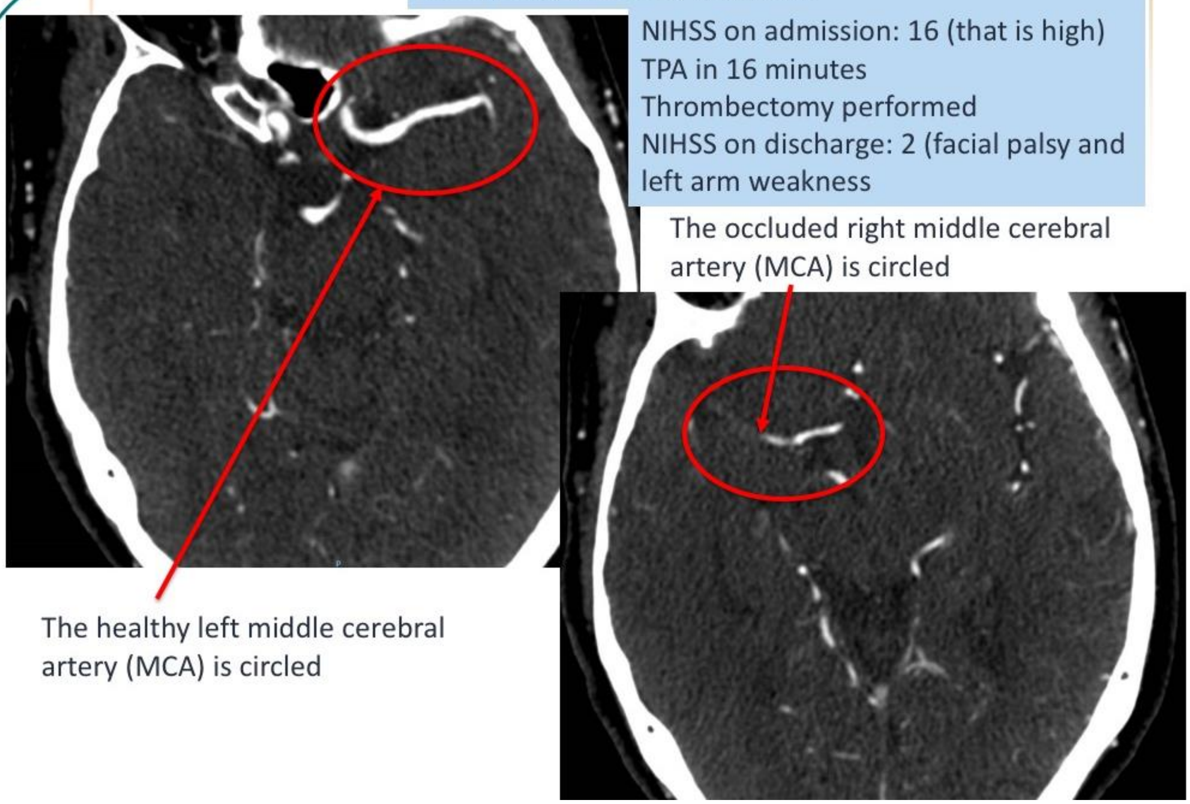
- **EMS**
  - **Report to MedCom and during bedside handoff**
  - **Chart results in your narrative.**
- **MedCom**
  - **Alert ED Attending physician per protocol for all CPSS+ and VAN+ reports from EMS**
  - **Free Text in Patient Report (pending other options**
- **ED Clinicians**
  - **Chart in a Quick Note**

University of Virginia Health System

74 y.o. female, PMH of afib, and breast CA. EMS called after she developed slurred speech, left side facial droop, and left sided weakness

NIHSS on admission: 16 (that is high)
TPA in 16 minutes
Thrombectomy performed
NIHSS on discharge: 2 (facial palsy and left arm weakness

The occluded right middle cerebral artery (MCA) is circled



The healthy left middle cerebral artery (MCA) is circled

University of Virginia Health System

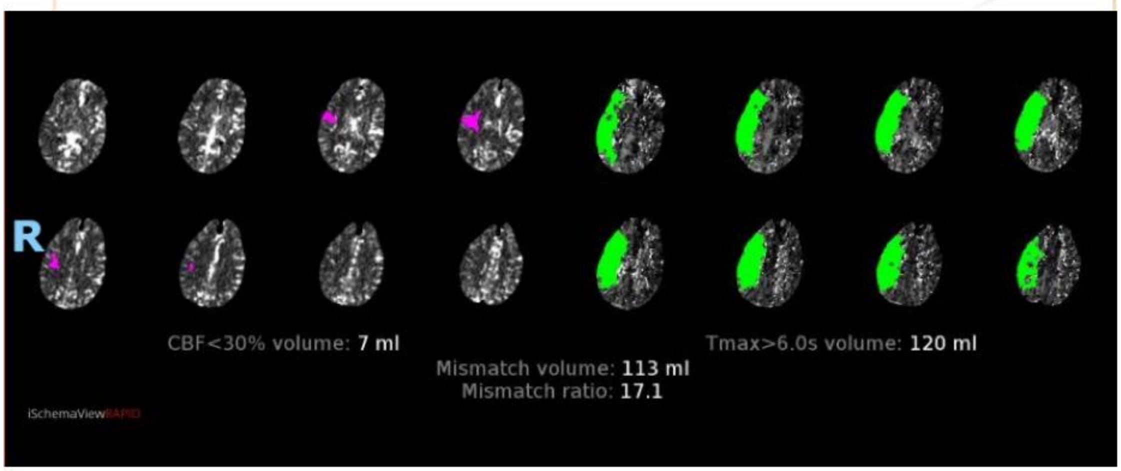
XXX (75) y.o. man with PMHx of HTN, bilateral carotid stenosis (severe L ICA stenosis), and HLD who presented to the UVA ED initially with painless vision loss of R eye starting at 2200 on 11/10. 6 hours later at 0415 on 11/11, in addition to persistent R vision loss, patient was stroke alerted with initial NIHSS at 14 (L sided facial droop, L sided plegia, L sided neglect, dysarthria) and sent to CT. After CTA Head/Neck, patient's NIHSS was 3. However, he continued to have left-sided facial droop and left-sided neglect which localized to the RMCA and R opthalmic artery. This is likely thromboembolic given steno-occlusive R sided carotid disease. tPA was given at 0613 after controlling SBP<180 with labetalol and nicardipine drip. He was not a thrombectomy candidate. He needs to be urgently evaluated by neurosurgery for potential endarterctomy.

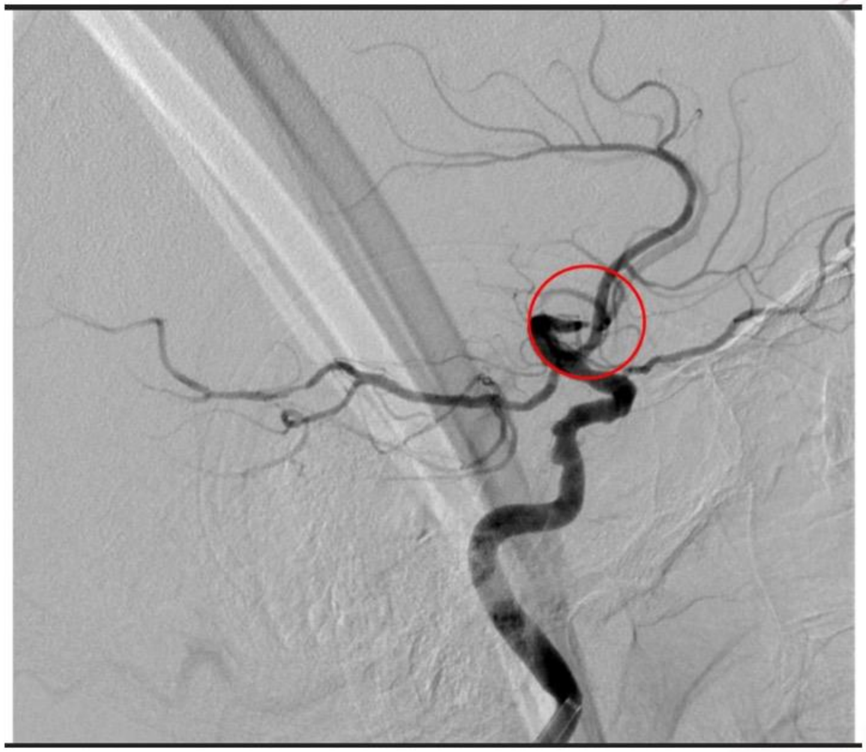
University of Virginia Health System

University of Virginia Health System

This is a 56 y.o. gentleman with a history of poorly controlled type 2 DM, HTN, and right Bell's palsy who presents to the UVA ER with dense left sided weakness, left facial droop, right gaze preference, and left sided neglect. During the stroke alert his gaze preference resolved. His deficits overall would localize to the right MCA territory, and imaging then showed a distal right MCA cut off with an associated perfusion deficit. He was a candidate for both tPA and thrombectomy. Unfortunately, tPA ultimately could not be administered as his blood pressure remained consistently >200 systolic despite administering 25mg of IV Labetalol, 10mg of IV Hydralazine, and having him on a Nicardipine gtt set to 15mg/hr for about 30 minutes. He was taken directly to the INR suite for thrombectomy and will be admitted to the NNICU afterwards under stroke Neurology."

University of Virginia Health System





ADDITIONAL RESOURCES

- Link to Protocol after it is accepted
- Strokevan.com

Appendix G. EMS protocol for Stroke Assessment including assessment for Large Vessel Occlusion

Stroke Large Vessel Occlusion Assessment Guidelines Vision Aphasia Neglect (VAN)	
Written: 18 JUNE 2018	Approved:

Providers at all levels should be able to complete a Cincinnati Prehospital Stroke Scale and Stroke Visual Aphasia Neglect (Stroke VAN) instrument on suspected stroke patients.

Initiating care of the clinically unstable patient takes precedence over stroke scale assessments.

Cincinnati Prehospital Stroke Scale and Stroke VAN **ARE NOT** triage tools used to make a decision to transport.

Cincinnati Prehospital Stroke Scale and Stroke VAN maybe assessed prior to and during transport. The assessment results should be calculated and included in reports care handoff to a medic, report to MEDCOM, and at bedside handoff in the ER.

If the patient has unstable vital signs **AND**/**OR** has a high risk history or complicated ALS complaints, reasonable attempts must be made to rendezvous with a medic level provider for transport.

Any change in patient status or condition should result in a medic being summoned to meet during transport. EMS should not delay transport while attempting to find or meet with a medic.

OVERVIEW, INDICATION, AND PROTOCOL OF STROKE ASSESSMENT & REPORTS

Stroke facts (Jarrett et al., 2013):

- **A stroke is a medical emergency**. Stroke occurs when blood flow is either cut off or is reduced, depriving the brain of blood and oxygen
- Stroke is the fifth leading cause of death in the US
- Stroke is a leading cause of adult disability
- On average, every 40 seconds, someone in the United States has a stroke
- Over 4 million stroke survivors are in the US
- The indirect and direct cost of stroke: $38.6 billion annually (2009)
- Crosses all ethnic, racial and socioeconomic groups

Ischemic Stroke	**Hemorrhagic Stroke**	**TIA**
• Caused by a blockage in an artery stopping normal blood and oxygen flow to the brain • 87% of strokes are ischemic • There are two types of ischemic strokes: **Embolism:** Blood clot or plaque fragment from elsewhere in the body gets lodged in the brain **Thrombosis:** Blood clot formed in an artery that provides blood to the brain	• About 13% of strokes are caused by a hemorrhage Caused by a breakage in a blood vessel within the brain • Can be the result of trauma or a ruptured aneurysm • There are two types of hemorrhagic stroke: Intraparenchymal (within the brain tissue, sometimes referred to as intracerebral) Hemorrhage: A blood vessel bursts leaking blood into the brain tissue Subarachnoid Hemorrhage: Occurs when a blood vessel bursts near the surface of the brain and blood pours into the area outside of the brain, between the brain and the skull	• A TIA or **Transient Ischemic Attack** produces stroke-like symptoms • TIA is caused by a clot; but unlike a stroke, the blockage is temporary and usually causes no permanent damage to the brain • Approximately 15% of all strokes occur after a TIA. **TIA is a medical emergency!**

(Acute Stroke: Types of Stroke, 2018 & Jarrett et al., 2013)

Any age group can suffer a stroke or TIA. EMS should calculate Cincinnati Prehospital Stroke Scale and Stroke VAN instrument if they have a clinical suspicion the patient is suffering a stroke.

Cincinnati Prehospital Stroke Scale and Stroke VAN instrument do not differentiate between types of stroke.

Communication to hospital medical communication and hospital-based clinicians should include results of stroke screening Instruments.

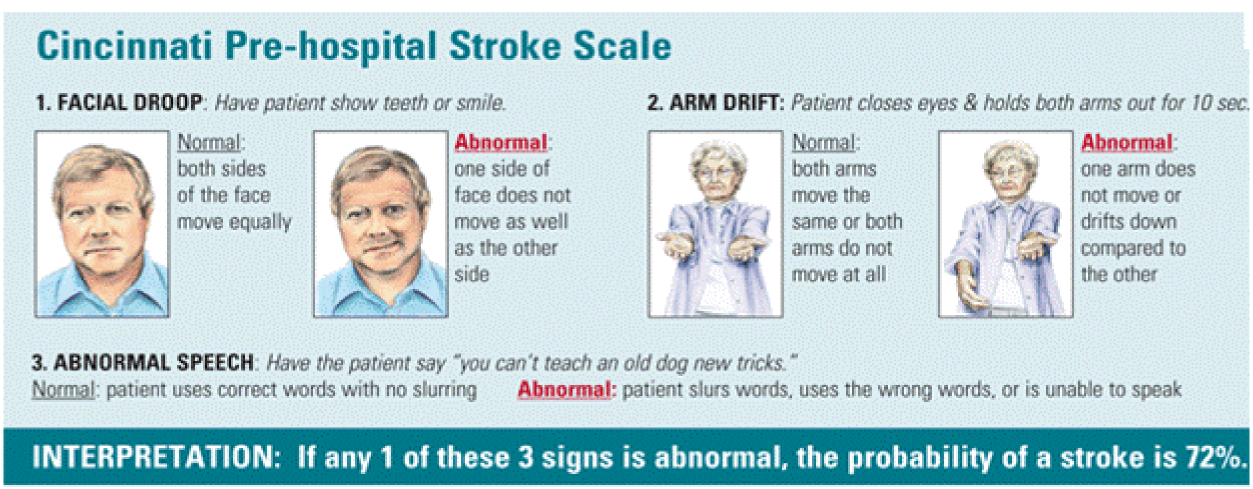
Cincinnati Prehospital Stroke Scale and Stroke VAN should be assessed q15 minutes before and during transport. Assessment results should be charted on the run sheet. The most recent and trends of the assessments should be reported during any report and bedside handoff.

PEARL/S:

HPI	Signs and Symptoms	Considerations
· Previous Stroke or TIA · Previous cardiac or vascular surgery · History of Diabetes, hypertension, coronary artery disease and atrial fibrillation · Medications (e.g. blood thinners) · History of trauma · History of cerebral vascular malformation or aneurism	· Altered mental status · Wake up or sudden onset weakness, paralysis · Wake up or sudden onset blindness or sensory loss · Aphasia, dysarthria · Syncope · Vertigo, dizziness · Headache, "thunderclap" headache · Seizure · Change in respiratory pattern · Hypertension or hypotension	· Stroke o Hemorrhagic o Thromboembolic o TIA · Seizure · Hypoglycemia · Tumor · Trauma · Intoxication

- **Obtain and document onset of symptoms (time last normal), medications and contact information for medical decision maker.**
- **Determine and report if the patient is taking:**
    - **warfarin (Coumadin®)**
    - **Heparin**
    - **clopidagrel (Plavix®)**
    - **Lovenox**
    - **xarelto (Rivaroxban®)**
    - **pradaxa (Dabigatran®)**
    - **apixaban (Eliquis®)**
- **Obtain Finger Stick Blood Glucose**
- **Determine if patient has history of diabetes, stroke, or seizure disorder**

Universal Protocol	
EMT	Identify witness to time last normal (TLN). Transport with patient if possible **AND** obtain contact information for immediate contact by ER
	Focused neurological exam. Cincinnati Prehospital Stroke Scale & Stroke VAN Repeat every 15 minutes.
	Instant glucose, 15 grams, for suspected hypoglycemia and able to maintain airway.
EN/A	IV/IO/Vascular Access
	Dextrose 50% 25 grams IV for suspected hypoglycemia. Glucagon[QVA*2] 1 mg IM (in thigh) if no IV access.
MED Control	Patients with Positive Cincinnati Stroke/VAN Scale **under 24 hours TLN,** contact medical command immediately for possible stroke alert and expedite transport. If the VAN Stroke Assessment is positive and transport time is greater than 30 minutes, consider rendezvous with air medical support if it does not delay patient transport.



If ARM weakness is present – continue to VAN EXAM

EMS VAN: Acute Stroke Screening Tool

(Arm Weakness + any VAN positive finding = POSITIVE VAN SCREEN)	YES	NO
Visual Disturbance? · **Field Cut (which side) (4 quadrants)** · **Double vision (ask patient and look to right then left, evaluate for uneven eyes)** · **Blind new onset**		
Aphasia? · **Expressive (inability to speak or errors) don't count slurring of words (repeat & name 2 objects)** · **Receptive (not understanding or following commands) (close eyes, make fist)** · **Mixed**		
Neglect? · **Forced gaze or inability to track to one side** · **Unable to feel both sides at same time, or unable to identify own arm** · **Ignoring one side**		

Appendix H. Medical Communication Center Stroke Alert Protocol

Stroke Alert

Purpose

To alert ER clinicians of a possible stroke alert

The policy will apply to only EMS agencies reporting both a Cincinnati Prehospital Stroke Scale (CPSS) AND a Stroke vision aphasia neglect (VAN) status during report. Participating agencies include Albemarle County Fire Rescue and Charlottesville Fire Rescue.

Policy

1. Nothing in this policy supersedes clinical judgment of EMS providers on scene or dispatchers in the medical communication center (MEDCOM) to contact the ER Attending Physicians for consultation. This pilot protocol provides supplemental information regarding strokes reported from the field and does not supersede UVA MEDCOM Policy 241.020: ED Attending Notification Criteria.

2. See Figure 1 & 2 for description of CPSS and VAN assessment tools

3. MEDCOM will notify the primary ER Physician Team (both Attending Physicians and Team Residents) and/or the ED Charge Nurse of all inbound patients meeting the criteria of a stroke alert.

4. The criteria for reporting a stroke alert is outlined in figure 3 and is as follows:

    a. **CPSS positive and VAN positive OR CPSS positive and VAN negative:** Medcom will facilitate a voice report from the on scene EMS provider to the one of the ER Attending Physicians if the on scene EMS provider reports a clinical suspicion of stroke. MEDCOM will flag the inbound patient on the ED arrival board. They will notify the ED Charge Nurse per protocol after the report is complete.

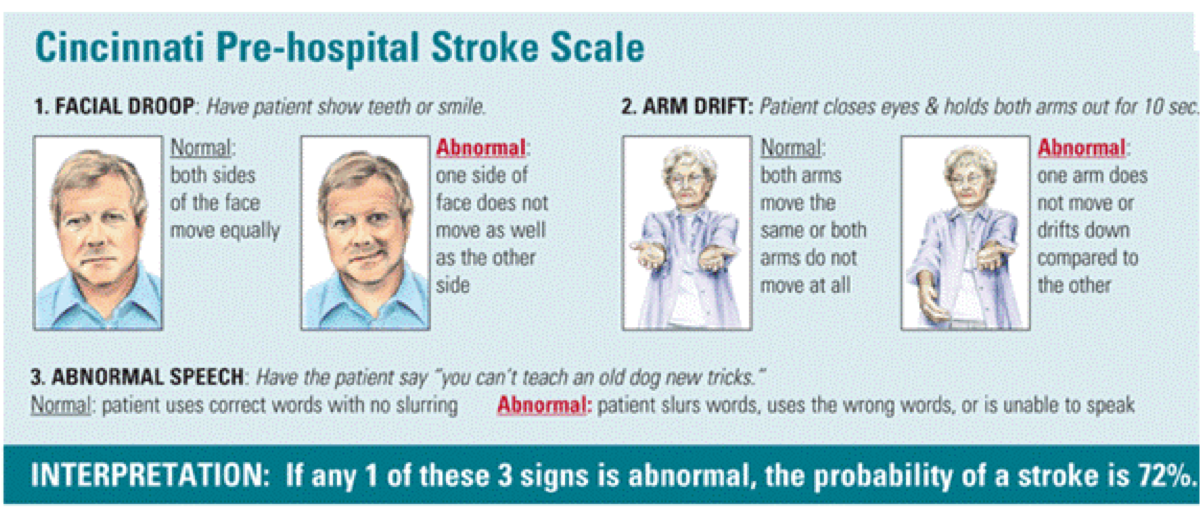
b. **CPSS negative** Medcom will notify the ER Charge Nurse per protocol for inbound patient if the medic on scene reports “CPSS negative”.

5. In the event an Attending requests Medcom to activate a Stroke Alert, medcom shall advise the requestor to <**Dial**> 4-2012 and request the Operator to activate a stroke alert.

6. MEDCOM will annotate EMS report of CPSS and VAN in the patient report free text comments section.

Reference Material

Cincinnati Prehospital Stroke Scale



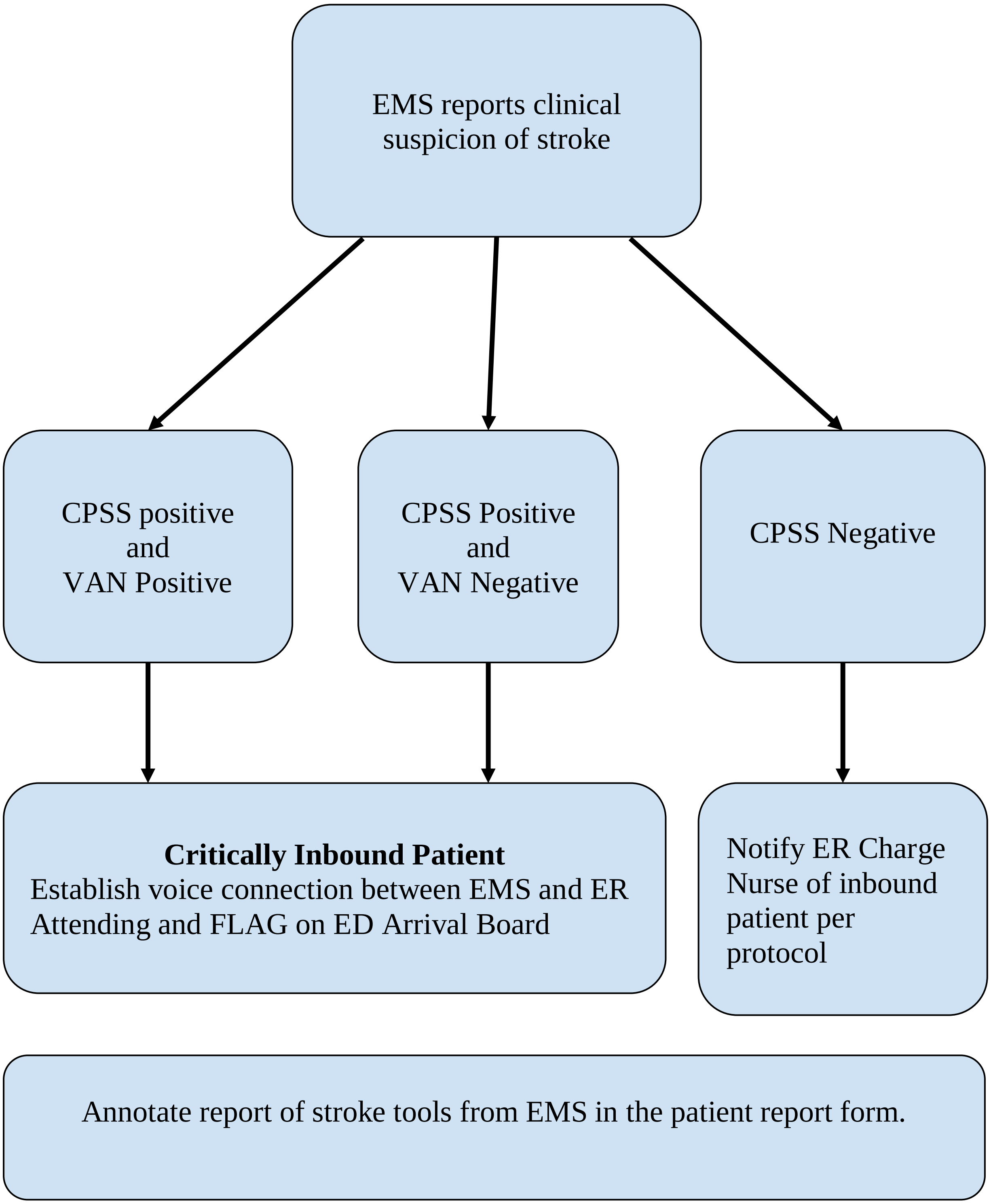
Stroke Vision Aphasia Neglect Screening for Large Vessel Occlusion

If ARM weakness is present – continue to VAN EXAM

EMS VAN: Acute Stroke Screening Tool

(Arm Weakness + any VAN positive finding = POSITIVE VAN SCREEN)	**YES**	**NO**
Visual Disturbance? · **Field Cut (which side) (4 quadrants)** · **Double vision (ask patient and look to right then left, evaluate for uneven eyes)** · **Blind new onset**		
Aphasia? · **Expressive (inability to speak or errors) don't count slurring of words (repeat & name 2 objects)** · **Receptive (not understanding or following commands) (close eyes, make fist)** · **Mixed**		
Neglect? · **Forced gaze or inability to track to one side** · **Unable to feel both sides at same time, or unable to identify own arm** · **Ignoring one side**		

Stroke alert decision three



Related Content

StrokeVAN information

https://www.strokevan.com/

American Heart Association EMS stroke training slide deck

http://www.strokeassociation.org/idc/groups/stroke-public/@wcm/@hcm/@sta/documents/downloadable/ucm_488744.pdf

Documents Attributes

Title	Stroke Alert		
Author	Aaron Matthews	**Date of Origin**	6/25/18
Reviewed/Revised by		**Dates Reviewed/revised**	
		Last Modified	
Approved			

Appendix I. ED Nurse Standard Work for Handover of Care from EMS Provider

Nurse Standard Work for Handover of Care from EMS Provider		
Last Updated:	Owner	Performed By:
Version: 1	Revised By:	Trigger
Scope: ED Nurses		

	Work performed by: (When)	**Major Step**	**Details**	**Importance**
1	ED Primary RN, ED Charge Nurse, and ED Team Lead RN (Alerted to an incoming stroke patient)	Determines if EMS reported stroke scale to medical communication center (MEDCOM) and if stroke alert has been called	MEDCOM will annotate stroke scales in patient report. Will not be displayed on message board. Positive stroke scale and VAN positive will be reported to ER Attending Physician MEDCOM will report any positive stroke scale to ED Attending Physician and ED Team Leader through text page.	Prompts ED nurses to communicate, prepare bed for inbound EMS patient, and engage team for peer coverage Reporting stroke and LVO tools clearly describes risk for Large Vessel Occlusion Stroke
2	ED Stroke RN (when receiving report from EMS provider)	Receives report from EMS provider. Collects patient's history of present illness (HPI) including stroke sensitive information	Stroke sensitive information includes from the EMS provider should include: 1. Vitals Signs 2. Time of onset and Time last normal 3. Stroke Scale and VAN assessments 4. Finger stick Blood Glucose 5. Current Medications. a. Ask about anticoagulation and antiplatelet 6. Medical and Surgical a. History Ask about history of diabetes, stroke, or known seizure disorder 7. Collect family/witness contact information	Promotes smooth and standardized handover of care with a complete prehospital clinical picture. Provides important and succinct information from the field that is relevant to care planning and medical decision making.

3	ED Stroke RN (when charting triage assessment	Annotates EMS report in triage note	Charts information from EMS hand over in EPIC triage note Annotate the information presented by the EMS provider in step 2	Provides standard location in the EHR for prehospital information that is relevant to care planning and decision making.
4	ED Stroke RN (when reporting patient status to colleagues in ED and on the Stroke Team)	Reports information to ED Clinician and Stroke Team	The RN should present the following information at a minimum; ● Time of onset and time last normal ● EMS stroke scale and VAN assessments ● RN's NIHSS assessment ● Updated vital signs ● Serum Blood Sugar or FSBG if available ● Home medication, especially anticoagulation and antiplatelet ● Medical and surgical history; especially diabetes, seizure disorders, and stroke. ● Updated vital signs ● Family and/or witness contact information if requested	Ensure standardized, safe, complete, and quality reports of stroke patients