Gap in Comprehensive Stroke Education for Emergency Department Nurses

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She has no known conflict of interest to disclose.

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Abstract

BACKGROUND: Strokes remain the number one cause of long-term disability in the United States. Delays in reperfusion after a stroke increase a patient's risk for unfavorable outcomes. **PURPOSE:** The purpose of this project is to decrease the time from patient's arrival to the emergency department (ED) to interventional radiology (IR) for mechanical thrombectomy intervention by educating nurses on how to identify IR-qualifying strokes using specific screening tools. Bandura's self-efficacy theory will serve as an essential model to guide this project. **METHODS:** A PowerPoint presentation and brochure were distributed to all ED nursing staff via email at a large urban teaching hospital in the Southwestern United States. These documents discussed the vision, aphasia, neglect (VAN) and balance, eyes, face, arm, speech, time (BE-FAST) screening tools which have high rates of reliability and validity in detecting large vessel occlusions (LVOs) and posterior circulation strokes. Included was a 5-question survey to assess for completion of provided material. Data on the facilities door-to-interventional radiology (IR) times were collected for two months and compared to data from the previous two months prior to the intervention. IRB approval was obtained from the project site. **RESULTS:** Average door-to-IR times at project site decreased by twenty-eight minutes after ED nurses received stroke screening tool education. **DISCUSSION/CONCLUSION:** The ability to recognize stroke symptoms consistent with LVOs and posterior circulation strokes upon arrival to the ED allows for timely IR intervention which supports better patient outcomes.

Keywords: stroke, VAN, BE-FAST, posterior circulation, large vessel occlusion

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According to Virani et al. (2020), approximately 720,000 individuals in the United States suffer from an ischemic stroke every year making it the number one cause of long-term disability. In an ischemic stroke, a vessel that supplies blood to the brain is obstructed resulting in neurological deficits. Treatment options are available to help relieve these obstructions and resolve patients' symptoms. However, these interventions are time-sensitive, and slight delays increase patients' risk for unfavorable outcomes. The significant consequences of delayed treatment support the urgent need to ensure nurses in the emergency department (ED) are appropriately trained to immediately recognize all signs of acute ischemic strokes (AIS), including more discrete symptoms consistent with posterior circulation strokes and large vessel occlusions (LVOs).

Problem Statement

Intravenous (IV) tissue plasminogen activator (tPA) and medical thrombectomy are the gold standard treatment options for acute ischemic strokes (Powers et al., 2019). The choice of treatment is determined by the time of symptom onset, the patient's presenting symptoms, the patient's brain imaging results, and the location of the occlusion. The most recent guidelines developed by the American Heart Association (AHA) and American Stroke Association (ASA) continue to recognize mechanical thrombectomy and IV tPA as the treatment of choice in AIS (Powers et al., 2019). Recent research supports these guidelines as mechanical thrombectomy shows more desirable long-term outcomes such as functional independence, improved cognitive function, and increased discharged to home rates compared to IV tPA alone for treatment (Jahan et al., 2019; McCarthy et al., 2019; Saver et al. 2016). Immediate recognition of posterior circulation and LVO symptoms upon the patient's arrival to the ED is crucial as the window of

eligibility for mechanical thrombectomy and tPA is small, and it has been found that minimal delays in reperfusion has shown a greater degree of long-term disability and decreased chance of excellent recovery (Goyal et al., 2019; Jahan et al., 2019; Powers et al., 2019).

Many screening tools such as FAST (face, arm, speech, time) and the National Institutes of Health Stroke Scale (NIHSS) are widely used by hospitals and emergency medical services to screen for acute strokes. While these tools are convenient and effective in recognizing common stroke presentations, they lack the ability to identify symptoms that are specific to posterior circulation strokes and LVOs. This lack of efficient screening results in unnecessary delay in care, which attributes to unfavorable patient outcomes.

Purpose and Rationale

Almost 50% of all AIS are large vessel and posterior circulation occlusions (Rennert et al., 2019). A study by Malhotra et al. (2017) evaluated the mortality and long-term functional outcomes of acute ischemic stroke patients with LVOs compared to non-LVOs. Patients with LVOs had a dependence and death rate of 64%, and non-LVO acute ischemic strokes had a death and dependence rate of 24% (Malhotra et al., 2017). These results support the need to immediately recognize LVOs as they account for a significant number of acute ischemic strokes and are linked to worsening functional outcomes and increased mortality. Another study by Gurley et al. (2019) found posterior circulation strokes to be misdiagnosed twice as often as strokes with occlusions in the anterior region of the brain. Misdiagnosis of posterior circulation occlusions leads to delayed intervention. The therapeutic effectiveness of reperfusion decreases with slight delays (Huang et al., 2019). The purpose of this project is to identify the impact ED nurses with stroke screening education can have on the time of arrival to the time of treatment for patients with LVOs and posterior circulation strokes.

Background and Significance

Nurses in the ED are responsible for triaging patients that arrive via privately owned vehicle and ambulance to the ED. They are also responsible for identifying stroke symptoms in patients prior to arrival based on the verbal report given by emergency medical services. Due to the patient's initial interaction being with an ED nurse, they must be properly trained to immediately recognize discrete symptoms of strokes seen with posterior circulation occlusions and LVOs (Ver Hage et al., 2018). Middleton et al. (2016) recognizes appropriate triage in the ED as a crucial element in stroke care. Inappropriate triaging can lead to delays in assessment and diagnosis, which causes delays in the implementation of stroke care (Middleton et al., 2016). Lack of efficiency in early hospital care, such as triaging errors, causes detrimental and unnecessary delays in treatment and puts the patient at increased risk for mortality and hospital re-admission (Man et al., 2020; Teleb et al., 2017).

VAN Assessment Tool

The VAN assessment tool is found to be highly effective in identifying LVOs. Previous research by Teleb et al. (2017) utilized the VAN assessment tool on 76 stroke patients in an emergency department. The results showed a 100% capture of LVOs and 90% specificity (Teleb et al., 2017). Another study by Navalkele et al. (2020) found VAN to have a high sensitivity rate when compared to other LVO screening tools such as Field Assessment Stroke Triage for Emergency Destination (FAST-ED). The VAN assessment tool is favored over other screening tools because of its simplicity in use (Navalkele et al., 2020). Initially patients will be assessed for motor weakness, if there is no weakness noted they are deemed VAN negative and no additional screening is indicated. If motor deficits are noted the patient continues to be screened for visual changes, aphasia, and neglect. If any of these additional symptoms are found, the

patient is considered VAN positive and can be at risk for an LVO, with no calculations indicated (Teleb et al., 2017).

BE-FAST (Balance, Eyes, Face, Arm, Speech, Time) Assessment Tool

Aroor et al. (2017), evaluated 736 patients with acute ischemic strokes using the FAST and BE-FAST screening tools. BE-FAST assesses for changes in balance and vision in addition to the basic FAST criteria. The BE-FAST screening tool captured 14% of acute ischemic strokes that would have been missed if the patient was only evaluated using the FAST tool (Aroor et al., 2017). Posterior circulation occlusions are the most commonly missed stroke so it is crucial that ED staff are using stroke screening tools that assess for balance, dizziness, and visual changes as these are common symptoms seen in patients with a posterior circulation occlusion that were initially misdiagnosed (Arch et al., 2016; Jones et al., 2021; Kim et al., 2021; Yamada et al., 2019).

Alternative Screening Tools

Teleb et al. (2017), performed a study that compared the accuracy of NIHSS to VAN in identifying LVOs. While both screening tools were successful in identifying patients with LVOs, VAN had a higher specificity. Ninety percent of VAN positive patients had an LVO, and only 74% of patients with an NIHSS score equal to or greater had an LVO (Teleb et al., 2017). The commonly used FAST tool also fails to assess for cortical symptoms, which is a crucial piece in recognizing LVOs. A study by Beume et al. (2018) found the presence of cortical symptoms, specifically aphasia, neglect, and hemiparesis (all contained in the VAN assessment tool) had a high sensitivity of 0.97 in identifying LVOs. FAST and NIHSS also fail to assess for acute dizziness which is the most common discrete symptom seen in posterior circulation strokes (Arch et al., 2016; Jones et al., 2021; Kim et al., 2021; Yamada et al., 2019).

Benefits of Early Intervention

Early identification of posterior circulation occlusions and LVO symptoms allows for proper activation of the stroke team, decreased time from arrival to medical imaging, prompt evaluation by an ED physician or neurologist, and ultimately swifter ED to treatment time with IV tPA or mechanical thrombectomy. Jahan et al. (2019) and Ver Hage et al. (2018) realized that early recognition of LVO to reperfusion time was associated with reduced neurological morbidity and improved long-term patient outcomes.

Internal Data

The stroke coordinator at a large urban teaching hospital in the Southeast United States reported there were 379 stroke alerts in the ED in 2020 (A. Wikas, personal communication, February 6, 2021). Twenty-nine of the 378 stroke patients went to interventional radiology (IR) for mechanical thrombectomy. The average time from ED arrival to IR arrival was eighty-one minutes. The goal for this facility is sixty minutes. Therefore, in the year 2020, this facility was twenty-one minutes over their goal time (A. Wikas, personal communication, February 6, 2021).

This inquiry has led to the PICOT question: in emergency department nurses, how does implementing stroke screening tool education compared to no education affect the door-to-IR time over a three-month period?

Search Strategy

To answer this PICOT question, an exhaustive literature search was performed. The scholarly databases referenced included: PubMed, Cumulative Index to Nursing and Allied Health (CINALH), and Cochrane Library. The three search engines used offer an advanced search option that allows for multiple keywords to be combined by the Boolean connector ‘OR’ and the Boolean connector ‘AND’ to expand results. The advanced search method was

implemented with each search and common keywords and MeSH terms were used including *stroke, CVA, cerebrovascular accident, TIA, transient ischemic attack, ischemic stroke, acute ischemic stroke, posterior circulation stroke, posterior stroke, posterior circulation, posterior circulation ischemic stroke, emergent large vessel occlusion, large vessel occlusion, large vessel ischemic stroke, LVO, ELVO, emergency department, ED, emergency room, ER, symptoms, stroke recognition, stroke detection, presentation, screening, detection, recognition, delayed detection, delayed recognition, early intervention, early detection, early recognition, early treatment, misdiagnosis, dizziness, mechanical thrombectomy, alteplase, tPA, treatment, intervention, therapy, door to needle, door to puncture, door to treatment, door to tPA, door to mechanical thrombectomy, and door to alteplase.* Additional filters were placed to exclude research that was published prior to 2016, used non-English language, and did not have full text options available.

PubMed

The initial search in PubMed yielded 188 results. This was narrowed down to 34 results after limits were applied. After close review of the titles and abstracts, six articles were chosen for further investigation.

CINAHL

A total of 291 results populated in the initial search within CINAHL. After filtering the results based on inclusion and exclusion criteria, the research was further condensed to 78 articles. Out of these, seven studies were considered for additional reviewing.

Cochrane Library

Cochrane produced 192 results in the initial search which was then narrowed down to 99 articles with the previously discussed limits. Eight of these articles were selected for close examination based on the abstracts and titles.

Critical Appraisal and Synthesis

Ten articles were appraised using a rapid critical appraisal tool to determine the strengths, weaknesses, and levels of evidence (Melnyk & Fineout-Overholt, 2019). All studies that underwent appraising were quantitative and primarily consisted of high levels of evidence such as meta-analyses, systematic reviews, and retrospective cohort studies/reviews as shown in the evaluation and synthesis tables below (Appendix A & B).

Each study had an adequate sample size with participants from various countries, including the United States of America, Germany, China, Korea, and Japan, which adds to the generalizability of the results (Appendix A, Table 1 and Appendix B, Table 2). The studies evaluated men and women with an average age ranging from 64-80 years of age. The age range was limited to older individuals since AISs are more commonly seen in this population. The majority of the articles evaluated outcomes of stroke interventions and the accuracy of stroke screening tools implemented by healthcare workers therefore, all studies took place in the hospital setting with two articles also including the pre-hospital setting (Appendix A, Table 1 and Appendix B, Table 2).

Each of the ten articles focused on door-to-intervention time, stroke screening tools, and initial symptom presentation as the independent variables. The dependent variables included functional outcomes, mortality, hospital re-admission, early stroke identification, and the location of the occlusion in the AIS.

Literature Search Conclusions

This literature review strongly supports the need for comprehensive stroke education to assist ED nurses in recognizing discrete symptoms of strokes seen in LVOs and posterior circulation strokes. Patients that present with less common stroke symptoms are at higher risk for misdiagnosis and unnecessary delays in care. The ability to accurately recognize stroke symptoms upon arrival to the emergency departments allows for early intervention. Further, recognizing the location of the occlusion based on the patient's presenting symptoms supports timely intervention by alerting healthcare providers to notify or activate additional resources such as mechanical thrombectomy. Early intervention with tPA and mechanical thrombectomy is strongly associated with better patient outcomes.

Theory Application

Theories are a crucial element in research as they help to develop and guide evidence-based practice. Bandura (1977) developed the self-efficacy theory to help understand a person's drive to succeed and how an individual's level of self-efficacy affects their coping behaviors, amount of expended effort, and ability to overcome challenges or adverse events. The self-efficacy theory contains four main components: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal (Appendix C). According to Bandura (1977), performance accomplishment focuses on the idea that repetitive successes increase self-efficacy, while failures decrease self-efficacy. The more victories experienced, the less likely an individual will be impacted by an infrequent failure. The second component of the theory, vicarious experience, suggests that a person is motivated to succeed by watching others master an activity or skill. Verbal persuasion is a skill often used to increase other's levels of self-efficacy because of its simplicity and accessibility. However, it is not as effective independently

and has shown to be more successful when combined with performance accomplishment or vicarious experience. Finally, high anxiety, fear-provoking thoughts, and emotional arousal negatively impacts an individual's performance which then affects one's level of self-efficacy (Bandura, 1977).

For emergency department nurses to successfully implement the BE-FAST and VAN assessment tools, they must have high levels of self-efficacy. Bandura's theory will serve as an important model for increasing levels of self-efficacy and success rates. These high rates of successful stroke identification will lead to permanent levels of high self-efficacy, which will encourage continued use of the BE-FAST and VAN screening tools to assist in early identification of LVOs and posterior circulation strokes.

Implementation Framework

Rosswurm and Larabee (1999) developed a model for evidence-based practice that was aimed to guide individuals through change. This model consists of six steps that will be closely followed during the implementation process of this project. The first three steps in the model are to assess the need for change in practice, link problem interventions and outcomes, and synthesize the best evidence (Appendix B). These steps have already been successfully completed by identifying the area of need, determining flaws in current practice based on available data, completing a robust literature search, and performing rapid critical appraisals on ten quality research articles to ensure high levels of evidence. The evidence from these ten articles were then synthesized (Appendix B).

Steps four and five focus on creating, implementing, and evaluating a practice change. Bandura's theory of self-efficacy will complement these steps by encouraging and empowering the individuals executing the change. The final step is to incorporate and maintain the change in

regular practice. When change is rushed and not evaluated adequately throughout the process, it is less likely to sustain. Therefore, following the critical steps in Rossswurm and Larabee's model for evidence-based practice is crucial to ensure changes are done properly so they can be maintained.

Ethical Considerations

Four ethical principles will guide this project: respect for person(s), beneficence, justice, and autonomy. Respect for persons is the principle that all individuals should be valued and treated with respect solely because they are humans (American Nurses Association, 2015). The project will adhere to this principle by respecting all participants in the study including nursing staff, stakeholders, and other project team members. Beneficence protects individuals from harm and ensures actions benefit others, often going beyond what is necessary to guarantee this (American Nurses Association, 2015). The project will adhere to this principle by providing education to better nurses practice and allow them to feel more comfortable identifying stroke patients. This principle also applies to the patients that will benefit from early recognition of stroke symptoms which will assist in early intervention and better long-term functional outcomes. The concept of justice supports moral rightness and suggests all individuals should be treated fairly (American Nurses Association, 2015). The project will adhere to this principle by ensuring all participants receive equal training and education. Autonomy is making informed decision for one's self through rational self-determination (American Nurses Association, 2015). The project will adhere to this principle by obtaining consent from nursing staff prior to participating in the study. At the time of consent, participants will be presented with the risks of participating in this study so they can make an informed decision.

Human Subjects Protection

CITI training for biomedical, social, and behavioral research was completed by the project lead and key project participants. This project was reviewed and approved by the project site and Arizona State University's institutional review board. Institutional review board approval ensures all human subject participants are protected and ethical dilemmas are considered and addressed. After receiving approval from Arizona State University, the project will begin.

Setting and Stakeholders

The project site is the ED at a large urban teaching hospital in the Southwest United States. This hospital has 746 beds, is a level 1 trauma center, and a magnet facility. The ED has 60 beds in addition to a six-bed trauma bay and a designated area to care for up to seven behavioral health patients. The ED cares for individuals requiring emergent stabilization and those with acute complaints or an exacerbation of a chronic condition. This ED employs registered nurses, physicians, physician assistants, nurse practitioners, respiratory therapists, physical therapists, patient care technicians, paramedics, patient financial services staff, environmental services technicians, medical imaging technicians, radiologists, case managers, social workers, nurse navigators, phlebotomists, transportation staff, and resident physicians of all specialties. The site has been a comprehensive stroke center since 2008 (Banner Health, n.d.). This certification is awarded by the Joint Commission and the American Heart Association (AHA)/American Stroke Association (ASA) and recognizes the facility's ability to provide care for the most complex stroke cases ("The Joint Commission," 2021). The project site's mission statement is to make health care easier, so life can be better.

Key stakeholders involved in this project are the ED Medical Director, the ED Nursing Director, the ED stroke coordinators, the Neurology Acute Care Nurse Practitioner, and the ED nursing managers. The support of each of these individuals plays a crucial role in the development and execution of this project. Other key stakeholders are the ED nurses and patients. Nurses are the targeted participants for this education and if the intervention is successful, nurses will increase their knowledge on LVOs and posterior circulation strokes, and patients will experience better long-term functional outcomes from decreased door-to-IR times.

Participants and Recruitment

The participants are registered nurses working in the ED at the project site. Individuals participating in the study must provide direct patient care, be employed full-time or part-time in the ED, and agree to participate in all aspects of the project. Exclusion criteria include minors (individuals under the age of 18) and adults who cannot consent. Participants will be recruited via email and consent is assumed with completion of the survey. A disclosure will be included in the email sent to the nursing staff stating, “Completion of the survey and participation in this project is voluntary. If you complete the survey you are confirming that you voluntarily consent to participate in this project, and you understand that participation in this project is not a condition of employment at Banner Health. You may complete this survey at work. If you elect to complete the survey on your own time, you will not be paid for your time spent on completing the survey. The completion of the video and survey is anonymous. All information received is confidential and data is de-identified.” The project stakeholders provided approval for staff to complete the education and testing while working and receive financial compensation for their time.

Project Description

This project will begin by developing a PowerPoint and brochure that contains information on the VAN screening tool, BE-FAST screening tool, and symptoms that are consistent with LVOs and posterior circulation strokes. It will also review which patients are potential candidates for mechanical thrombectomy with IR, the different timeframes of eligibility for stroke interventions, and the importance of quick stroke recognition and reperfusion. After educational tools are finalized, they will be reviewed with the stroke NP and ED medical director to check for accuracy. After approval is received, the ED RN manager will send the PowerPoint and brochure to all ED nurses at the project site via employee email. Included in this email will be a link to a survey that contains five questions. The survey will be used to track employee completion. Participation is optional and consent is assumed with completion of the survey.

Potential barriers in implementation include pushback from ED nurses because of lack of motivation to perform additional screening tools and lack of time to complete different assessments when triaging. Staff might also be resistant to change. To address these barriers an emphasis will be placed on the importance of decreasing door-to-IR times to support better long-term functional outcomes in patients and decreased hospital re-admission rates which can be a burden to the healthcare system. The education material will also include information on the ease of use of these screening tools. Repetitive successful identification of discrete stroke symptoms will hopefully lead to high levels of self-efficacy like discussed in Bandura's self-efficacy theory. Ideally, this performance accomplishment will lead to increased staff motivation to utilize the screening tools.

Data Collection and Outcomes Measurement

The effectiveness of the intervention will be measured by gathering data on the number of minutes it takes for a patient to arrive at IR for mechanical thrombectomy from the ED. Data on door-to-IR times will be collected every month for two months by the stroke coordinator. This data will be compared to data from the previous two months prior to the nurses receiving the stroke screening tool education. All de-identified, aggregate data collected by the stroke coordinator will be displayed in an excel sheet and stored on the project leads personal laptop secured with a password. At the completion of the project, this data will be analyzed using a two-tailed paired samples t-test comparing pre- and post-intervention door-to-IR times.

Budget and Funding

The education material created for this project was entirely electronic and developed by the project lead on their personal computer. Therefore, no funding was needed for content development. The estimated cost of staff time including ED nurses and stakeholders was calculated to be approximately one-thousand dollars (Appendix E). This includes the time stakeholders spent reviewing material, the average time ED nurses spend viewing the educational video and handouts, and the time spent by the stroke coordinator gathering and de-identifying stroke data. Banner Health will be compensating all employees including ED nurses, stroke coordinator, and stakeholders for their time.

Results

During the two-month pre-intervention period, there were seven IR cases. The average door-to-IR time for these seven cases was one-hundred and five minutes. There were also seven IR cases in the two-month post-intervention phase with an average door-to-IR time of seventy-

seven minutes. Therefore, the average door-to-IR time decreased by twenty-eight minutes after providing ED nurses with stroke screening tool education (Appendix F).

This data was analyzed using a two-tailed paired samples *t*-test which examined the mean difference between pre- and post-intervention data to determine statistical significance. The Shapiro-Wilk and Levene's test results were not significant based on an alpha value of .05, $t(6)$, $p = .420$, indicating the null hypothesis cannot be rejected (Table 1). These findings suggest that the mean of the pre- and post-data was not significantly different from zero.

Table 1

Two-Tailed Paired Samples t-Test for the Difference Between Pre and Post

Pre		Post				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
105.14	83.53	76.71	27.43	0.86	.420	0.33

Note. N = 7. Degrees of Freedom for the *t*-statistic = 6. *d* represents Cohen's *d*.

This project will positively impact patients' physical and emotional well-being due to the potential for severe neurological deficits after suffering a stroke and the strong evidence recognizing better patient outcomes with early recognition and treatment. Caregivers, friends, and family members of the patients may also benefit from decreased emotional stress caused by severe deficits and a reduced burden from the patient's physical limitations. In addition, with a reduction in hospital readmission and a decline in needs for additional services such as therapy and rehab related to poor functional outcomes, there will be less of a burden on healthcare providers and the overall healthcare system.

The ease of accessibility, simplicity, and cost effectiveness of this intervention will make it easily sustainable. Nurses at this project site are required to complete annual education modules on various topics. The PowerPoint, brochure, and survey utilized in this project can be

included in the required education. Education material may require slight modifications in the future to reflect the latest evidence-based practice.

Discussion

Though the results of this project did not reach statistical significance, there was a negative trend in door-to-IR times, which supports the continued use of this intervention. Previous research by Ver Hage et al. (2018) also found a reduction in door-to-IR times using the VAN screening tool. The ability to accurately recognize stroke symptoms upon arrival to the emergency departments allows for early intervention. Further, identifying the occlusion location based on the patient's presenting symptoms supports timely intervention by alerting healthcare providers to notify or activate additional resources such as IR for mechanical thrombectomy.

Limitations of this study include a short-intervention timeframe of two months. This also resulted in a small sample size of seven pre-intervention cases and seven post-intervention cases for a total of fourteen cases. Additional barriers were poor employee engagement. Approximately ten percent of the ED staff completed the optional survey indicating completion of education material. However, this data is not an accurate reflection of employee participation because the survey was optional. Employees also had the ability to complete the survey without viewing the education material. Finally, only aggregate data was collected for the project, which did not allow for screening of additional factors that could have affected door-to-IR times.

Future research should lengthen the intervention timeframe to allow for more data. It should also focus on accurately tracking participation and the percentage of screening tool usage during triaging and assessing to allow for more reliable results. Screening for other factors that may have influenced door-to-IR times for each case would also increase the reliability of data. Finally, measuring the number of strokes that were misdiagnosed or not recognized upon patient

arrival would assist in evaluating the effectiveness of stroke screening tool education for ED nurses.

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Appendix A

Evaluation and Synthesis Tables

Table 1 Quantitative Evaluation Table

Citation	**Theory/ Conceptual Framework**	**Design/ Method**	**Sample/ Setting**	**Major Variables & Definitions**	**Measurement/ Instrumentation**	**Data Analysis (stats used)**	**Findings/ Results**	**Level/Quality of Evidence; Decision for practice/ application to practice**
Arch et al. (2016). Missed ischemic stroke diagnosis in the emergency department by emergency medicine and neurology services **Country:** United States **Funding:** Not mentioned	Not explicitly stated	**Design:** Retrospective chart review **Purpose:** Examine the diagnosis of AIS in the emergency department	N= 465 **Demographics:** Age (mean): 72.3 M/F: 212/253 329 participants were White **Setting:** Academic hospital and community hospital **Inclusion:** >18 years of age, admitted to the hospital with	**IV:** Initial stroke symptoms **DV:** Accuracy of initial diagnosis	Strokes that were missed verses strokes that were recognized in the initial diagnosis	IBM SPSS Statistics (version 21) software package. P<0.05 indicated statistical significance in all analyses.	Out of 465 patients with AIS, 22% were initially misdiagnosed. 37% of posterior strokes were initially misdiagnosed compared with 16% of anterior strokes. Most commonly missed symptoms were N/V, dizziness, and	**Level of Evidence:** LOE 3 **Strengths:** Detailed analyses performed for all stroke symptoms and demographic data **Weaknesses:** Data was obtained from the EMR, used charts from 2 different hospitals with different

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Bias: Not mentioned			a primary discharge diagnosis of stroke, had a confirmed AIS seen on CTA or MRI **Exclusion:** Had a clinical TIA without imaging correlation, primary intracerebral hemorrhage, were transferred from an outside hospital after stroke diagnosis was already suspected, and venous infarct **Attrition:** Not mentioned				a positive stroke history	databases and methods of recording, patients with incorrect discharge diagnosis were not included which might lead to an under-representation of true missed AIS, and population was predominantly white older males. **Conclusions:** Atypical symptoms associated with posterior circulation strokes lead to misdiagnoses

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
								Feasibility: Feasible with appropriate education on recognizing atypical symptoms
Beume et al. (2018). BE-FAST (balance, eyes, face, arm, speech, time) **Country:** Germany **Funding:** BrainLinks-BrainTools Cluster of	Not explicitly stated	**Design:** Retrospective Cohort Study **Purpose:** To determine how effective cortical symptoms are at determining LVO strokes and candidates for mechanical	N= 543 **Demographics:** Age (median): 74 years M/F: 57.1%/42.9% **Setting:** Hospital/Pre-Hospital **Inclusion:** Arrived at the ED within the	**IV:** Stroke symptoms **DV:** Location of ischemic occlusion	Calculated the number of patients that presented with aphasia, hemiparesis, neglect/gaze deviation, any cortical symptom, cortical symptom AND hemiparesis, and cortical symptom	All statistical analyses were performed using SPSS software (version 23.0)	Cortical symptoms alone showed to be a reliable indicator for LVOs and mechanical thrombectomy candidates. Specificity and sensitivity were higher in cortical	**Level of Evidence:** LOE 2 **Strengths:** Thorough data analysis completed with detailed charts of results **Weaknesses:** Single-center study, no other

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Excellence funded by the German Research Foundation **Bias:** None		thrombectomy	4.5-hour timeframe **Exclusion:** Patients with intracerebral hemorrhage, TIA, and stroke mimics **Attrition:** Not mentioned		OR hemiparesis. Then calculated which of these patients had LVOs.		symptoms only compared with motor deficits.	screening tools were applied outside of NIHSS, excluded pts outside of the 4.5-hour window **Conclusion:** In the prehospital setting, the presence of cortical symptoms is a reliable indicator for detecting LVOs **Feasibility:** Assessing patients for cortical symptoms is simple and feasible for

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
								implementation in practice
Goyal et al. (2019). Rapid alteplase administration improves functional outcomes in patients with stroke due to large vessel occlusion **Country:** Not mentioned **Funding:** A grant from Medtronic LLC to the University of Calgary	Not explicitly stated	**Design:** Meta-Analysis **Purpose:** To determine the relation of onset-to-treatment time and door-to-needle time with functional outcomes and mortality among patients with AIS with imaging-proven LVO	N=601 **Demographics:** Age (mean): 66.0 years M/F: 50%/50% **Setting:** Endovascular hospitals **Inclusion:** Pts with AIS with documented LVO who received IV tPA alone **Exclusion:**	**IV:** Onset-to-treatment time and door-to-needle time **DV:** Functional outcomes and mortality	Generalized linear mixed models, including a cumulative logit link function for the multinomial primary outcome of mRS and a logit link function for all other outcomes	SAS, version 9.4 (SAS Institute, Cary, NC) and R, version 3.2 (R foundation for Statistical Computing, Vienna, Austria). *P* values were 2 sided and $P<0.05$ indicated statistical significance in all analyses.	Each 60-minute onset-to-treatment time delay was associated with greater disability at 90 days. The odds of functional independence at 90 days was 0.82 and dropped to 0.55 with each 60-minute delay.	**Level of Evidence:** LOE 1 **Strengths:** All participants provided informed consent according to each trial protocol, and each study was approved by the local ethics board. **Weaknesses:** The principal risk of bias derived from differences among individual study methods

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Bias: None		treated with IV tPA	Patients who received tPA in a peripheral hospital before transfer to the endovascular center **Attrition:** Not mentioned					and inclusion criteria **Conclusions:** Faster IV tPA delivery is associated with less disability at 3 months among patients with LVO.
Huang et al. (2018). Effects of time delays on the therapeutic outcomes of intravenous thrombolysis for AIS in the posterior circulation: An	Not explicitly stated	**Design:** Observational Study **Purpose:** To demonstrate the effects of time delays on the therapeutic	N= 95 **Demographics:** Age (median) 64.0 years M/F- 69.5/30.5% **Setting:** Hospital **Inclusion:**	**IV:** OTT with IVT and angiographic recanalization **DV:** Rates of favorable outcome and mortality	mRS to measure favorable outcomes and percentage rate of recanalization	SPSS 19.0, Mann-Whitney U Test, Pearson chi-squared test, and Cochran-Armitage trend test	The rates of favorable outcomes in patients with OTTs of 0–90 min, 91–180 min, 181–270 min, and ≧271 min was 100.0%, 71.1%,	**Level of Evidence:** LOE 3 **Strength:** Was approved by an ethics board, extensive objective information on participants

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
observational study **Country:** China **Funding:** Not mentioned **Bias:** None		outcomes of IVT in acute posterior circulation stroke pts.	A definite and persistent neurological deficit, age > or equal to 18 years, and OTT < or equal to 4.5 hours. **Exclusion:** Intracranial hemorrhage or other contraindications of IVT therapy **Attrition:** Not mentioned				67.6%, and 73.3%	**Weaknesses:** Small sample size, retrospective study design **Conclusion:** The therapeutic effects of recanalization after IVT decreased significantly with longer time delays in posterior circulation stroke pts. **Feasibility:** Feasibility based on available resources

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Jones et al. (2021). Characteristics of patients who had a stroke not initially identified during emergency prehospital assessment: A systematic review **Country:** Studies included from any country as long as it is written in the English language **Funding:**	Not explicitly stated	**Design:** A systematic review **Purpose:** To identify the characteristics of acute stroke presentations associated with inaccurate EMS identification (false negatives)	N= 6934 **Demographics:** A limited number of studies in this systematic review included demographic information on the participants **Setting:** Hospital and pre-hospital **Inclusion:** Studies including pts who had a stroke and were 18 years of age or older, any stroke type was included, pts in studies had to be	**IV:** Acute stroke presentations **DV:** Inaccurate EMS identification or false negatives	The included studies were described narratively because of heterogeneity between study settings, designs, and screening tools used	Results are reported as presented in the original studies, and no additional secondary analyses have been undertaken	Out of 6934 AIS and TIA pts, there were 1774 false negative pts. Commonly documented symptoms in false negative cases were N/V, dizziness, changes in mental status, and visual disturbance/ impairment	**Level of Evidence:** LOE 1 **Strengths:** Study quality was assessed using the QADAS-2 tool. **Weaknesses:** The combined data did not undergo additional data analyses, 14/21 studies included were at high risk for selection bias, only included studies reported in English

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The University of Central Lancashire Research Institute for Global Health and Well-being (LIFE) **Bias:** One of the authors of this work has other authored papers included in this systematic review			screened by a health professional including paramedics or technicians within the prehospital setting, and data must have been reported on prehospital diagnostic accuracy and/or symptoms present **Exclusion:** Non-stroke populations, studies including only stroke mimics, studies utilizing prehospital					**Conclusion:** Speech problems and posterior circulation symptoms were the most commonly documented symptoms among stroke presentations that were not correctly identified by EMS (false negatives) **Feasibility:** It is feasible to screen patients for speech problems and posterior circulation symptoms

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			screening tools to identify LVOs **Attrition:** Not mentioned					
Kim et al. (2021). Stroke prediction in patients presenting with isolated dizziness in the emergency department **Country:** Korea **Funding:** Not mentioned **Bias:** None	Not explicitly stated	**Design:** Retrospective Observational Study **Purpose:** To evaluate the prevalence of acute stroke in patients who presented with isolated dizziness without neurological deficits at the ED.	N= 1239 **Demographics:** Age (median): 64 years M/F: 537/702 **Setting:** Emergency Department **Inclusion:** All adult pts hat presented with isolated dizziness **Exclusion:**	**IV:** Presence of AIS **DV:** Dizziness without neurological deficits	Demographics, past illnesses, drug therapy, symptoms, vascular territory, lab values	The Kolmogorov –Smirnov test, Mann–Whitney U test, chi-squared test and Fisher's exact test were performed as appropriate. A stepwise multivariate logistic regression analysis was. Variables	55 out of 1239 patients (4.5%) who presented with dizziness without confirmed neurologic deficits, and most cases (96.3%) were diagnosed as ischemic stroke with a high rate of cerebellum involvement	**Level of Evidence:** LOE 2 **Strengths:** Detailed data collection on participants **Weaknesses:** Single center, retrospective design, and potential selection bias **Conclusion:**

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			Pts with confirmed neurologic deficits at presentation, pts with dizziness as a result of external clinical factors, and pts without MI data **Attrition:** Not mentioned			with *p* values of less than 0.1 in univariable analyses were selected for the multivariable analysis		Dizziness without neurological deficit accounted for 4.5% of strokes in an ED. **Feasibility:** It is feasible to screen patients that present with dizziness for stroke. May use additional resources such as CTA and MRI
Man et al. (2020). Association between thrombolytic door-to-needle time and 1-year mortality	Not explicitly stated	**Design:** Retrospective Cohort Study **Purpose:** Evaluate the relationship between door	**Demographics:** Age (median) 80 years M/F- 43.5/56.5% **Setting:**	**IV:** Time from symptom onset to tPA administration **DV:**	Number of pts with mortality or re-admission within 1-year of AIS with tPA administration. Rate of mortality and re-admission	Pearson χ^2 Wilcoxon rank-sum test	Shorter door to tPA time was associated with lower mortality and hospital	**Level of Evidence:** LOE 2 **Strengths:** Large sample size

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
and readmission in patients with AIS **Country:** United States **Funding:** AHA/ASA, Novartis, Boehringer Ingelheim Lilly, Novo Nordisk, Sanofi, AstraZeneca, and Bayer **Bias:** None		to tPA initiation and long-term mortality and hospital readmission in pts with AIS.	Hospitals (teaching hospitals, primary stroke centers, rural hospitals) **Inclusion:** Pts 65 years+ who received tPA within 4.5 hours of symptom onset **Exclusion:** Pts who received intra-arterial perfusion techniques or did not have a documented door to tPA time. Pts who were transferred to another hospital, left	Long-term mortality and hospital-readmission within one year of AIS	were divided into 3 categories based no cause: all-causes, cardiovascular related, or stroke readmission.		readmission rates.	**Weaknesses:** Data was self-reported by hospitals, they only studied adults age 65+, rural and minority populations were underrepresented, they did not examine functional outcomes, and cause of death was not studied. **Conclusion:** Longer door to tPA administration times were significantly associated with higher all-cause mortality and

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
			AMA, or did not have a documented site of DC disposition. **Attrition:** Not mentioned					higher likelihood of readmission at 1-year. **Feasibility:** Recommended for use in practice because of effectiveness.
Navalkele et al. (2020). Vision, aphasia, neglect assessment for large vessel occlusion stroke **Country:** United States **Funding:** None	Not explicitly stated	**Design:** Retrospective study **Purpose:** Validate the VAN assessment tools ability to recognize LVOs	N= 244 **Demographics:** Age (mean): 66 years of age M/F: 119/125 **Setting:** Hospital **Inclusion:** 18 years of age or older and NIHSS	**IV:** VAN Assessment **DV:** LVO detection	Scores of VAN, NIIHSS, FAST-ED, RACE, and CPSS	C statistics was calculated to measure the accuracy of predicting LVO with each screening tool	When compared to other screening tools such as NIHSS, FAST-ED, RACE, and CPSS, VAN showed comparable sensitivity and specificity	**Level of Evidence:** LOE 2 **Strengths:** Conducted at a large volume center, validated the VAN assessment screening tool in a large prospective dataset.

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Bias: None			performed on arrival **Exclusion:** Arrival greater than 24 hours of LKW, CTA or MRU not obtained within 6 hours of arrival or before IV tPA **Attrition:** Not mentioned					**Weaknesses:** Only a single center data and limited generalizability. **Conclusion:** VAN is able to identify LVOs with adequate accuracy in the hospital setting **Feasibility:** VAN assessment is feasible because it is simple and effective
Saver et al. (2016). Time to treatment with endovascular	Not explicitly stated	**Design:** Meta-Analysis	N= 1287 **Demographics:** Age (mean): 66.5 years M/F:	**IV:** Time for symptom onset to MT	Measured degree of disability, functional outcome, and mortality at 3	Used mixed-method ordinal logistic regression	Compared with medical therapy alone, MT up to 7.3 hours after	**Level of Evidence:** LOE 1

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
thrombectomy and outcomes from ischemic stroke: A meta-analysis **Country:** Not explicitly stated **Funding:** Grant from Medtronic to the University of Calgary **Bias:** None		**Purpose:** To determine the relationship between time-to-treatment and outcome from endovascular MT for AIS	53%/47% **Setting:** Hospitals with stent retrievers or other second-generation devices **Inclusion:** All randomized phase 3 trials in which stent retrievers or other second-generation devices were used in the majority of endovascular interventions for treatment of acute ischemic stroke, and for which a peer-reviewed,	**DV:** Rate of functional independence	months using mRS	and mixed-method binary logistic regression.	symptom onset was associated with improved outcomes. Rates of functional independence after MT were 64% with reperfusion at 3 hours vs 46% with reperfusion at 8 hours	**Strengths:** All included trials enrolled pts with ethics approval from the local institutional boards **Weaknesses:** Differences in entry criteria for different trials is a source of potential bias and only measured functional outcome up to 3 months **Conclusion:** In AIS due to LVO, endovascular MT should be initiated as soon

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
			complete primary results manuscript was published by July 1, 2016 **Exclusion:** Not included **Attrition:** Not mentioned					as possible within the first 7 hours as soon as possible **Feasibility:** Feasible with the necessary resources for
Yamada et al. (2019). DEFEENSIVE stroke scale: Novel diagnostic tool for predicting posterior circulation infarction in the emergency department	Not explicitly stated	**Design:** Retrospective and Prospective Cohort Study **Purpose:** To determine the frequency of misdiagnosis of a posterior	**Demographics:** *Prospective* N=949 *Retrospective* N=115 Age (median) 67 years M/F- 33.4/66.6% **Setting:**	**IV:** DEFENSIVE stroke screening scale **DV:** Ability to detect posterior circulation strokes	Measured the proportion of subjects with an AIS who were not properly diagnosed in the ED, the sensitivity, specificity, PPV, and NPV of the AIS diagnosis, the NIHSS score,	SPSS Version 23	6 out of 115 patients who were hospitalized due to AIS were misdiagnosed in the ED. Out of these pts all 6 had infarcts in the	**Level of Evidence:** LOE 3 **Strength:** Performed a retrospective and prospective study **Weaknesses:** Observational study without

Key: **AIS-** acute ischemic stroke; **AMA-** against medical advice; **CPSS-** Cincinnati pre-hospital stroke scale; **CTA-** computed tomography angiograph; **DC-** discharge; **DV-** dependent variable; **DWI-** diffusion-weight imaging; **ED-** emergency department; **EMS-** emergency medical services; **F-** female; **FAST-ED-** field assessment stroke triage for emergency destination; **IV-** independent variable; **IVT-** intravenous thrombolysis; **LKW-** last known well; **LOE-** level of evidence; **LVO-** large vessel occlusion; **M-** male; **MRI-** magnetic resonance imaging; **mRS-** modified rankin scale; **MT-** mechanical thrombectomy; **NIHSS-** National Institutes of Health Stroke Scale; **NPV-** negative predictive value; **N/V-** nausea/vomiting; **OTT-** onset-to-treatment time; **PPV-** positive predictive value; **pt-** patient: **QADAS-2-** quality assessment of diagnostic accuracy studies V.2; **RACE-** rapid arterial occlusion evaluation scale; **TIA-** transient ischemic attack; **tPA-** alteplase; **UK-** United Kingdom; **USA-** United States of America; **VAN-** vision, aphasia, neglect

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
Country: Japan **Funding:** None **Bias:** None		circulation infarction in pts who presented with dizziness and to develop a new scale that increases the diagnostic accuracy of posterior circulation strokes.	Single medical center serving as a regional stroke referral center **Inclusion:** Pts who visited the ED with acute dizziness, disequilibrium, floating sensation, imbalance, and vertigo **Exclusion:** Subjects with incomplete or poorly documented neurological examinations **Attrition:** Not mentioned		and the proportion of subjects with a DWI negative infarction.		posterior circulation. The prospective cohort study using the DEFENSIVE screening tool had a sensitivity of 100% and specificity of 89.4%. AIS was diagnosed in 10.5% (100/949) of all subjects with acute dizziness and related symptoms using the DEFENSIVE stroke scale	randomization, education of staff possibly influenced outcome, not all pts followed up for repeat MRI so some pts with misdiagnosed AIS could have been missed. **Conclusions:** The DEFENSIVE stroke scale has good diagnostic accuracy and is easy to administer **Feasibility:** Recommended for use in practice because

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Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis (stats used)	Findings/ Results	Level/Quality of Evidence; Decision for practice/ application to practice
								of simplicity and effectiveness

Key: **AIS-** acute ischemic stroke; **AMA-** against medical advice; **CPSS-** Cincinnati pre-hospital stroke scale; **CTA-** computed tomography angiograph; **DC-** discharge; **DV-** dependent variable; **DWI-** diffusion-weight imaging; **ED-** emergency department; **EMS-** emergency medical services; **F-** female; **FAST-ED-** field assessment stroke triage for emergency destination; **IV-** independent variable; **IVT-** intravenous thrombolysis; **LKW-** last known well; **LOE-** level of evidence; **LVO-** large vessel occlusion; **M-** male; **MRI-** magnetic resonance imaging; **mRS-** modified rankin scale; **MT-** mechanical thrombectomy; **NIHSS-** National Institutes of Health Stroke Scale; **NPV-** negative predictive value; **N/V-** nausea/vomiting; **OTT-** onset-to-treatment time; **PPV-** positive predictive value; **pt-** patient: **QADAS-2-** quality assessment of diagnostic accuracy studies V.2; **RACE-** rapid arterial occlusion evaluation scale; **TIA-** transient ischemic attack; **tPA-** alteplase; **UK-** United Kingdom; **USA-** United States of America; **VAN-** vision, aphasia, neglect

Appendix B

Synthesis Table

Table 2

Studies		Arch et al.	Beume et al.	Goyal et al.	Huang et al.	Jones et al.	Kim et al.	Man et al.	Navalkele et al.	Saver et al.	Yamada et al.
Basic Study Data	Year	2016	2018	2019	2019	2021	2021	2020	2020	2016	2019
	LOE	3	2	1	3	1	2	2	2	1	3
	Design	RCR	RCS	MA	OS	SR	ROS	RCS	RCS	MA	R&PCS
	Mean Age (y)	72.3	74	66	64	N/A	64	80	66	66.5	67
	Bias	None	None	None	None	LR	None	None	None	None	None
	# of Participants	465	543	601	85	6934	1239		244	1287	115
	Setting	H	H/PH	H	H	H/PH	H	H	H	H	H
Independent Variables	DTI time			•	•			•		•	
	Stroke screening tool								•		•
	Presenting symptoms	•	•			•	•				
Dependent Variables	Functional outcomes			•	•					•	
	Mortality			•	•			•			
	Hospital re-admission							•			

Key: **AIS-** acute ischemic stroke; **CS-** cortical symptom; **DTI-** door-to-intervention; **H-** hospital; **LR-** low risk; **LVO-** large vessel occlusion; **MA-** meta-analysis; **OS-** observational study; **PH-** pre-hospital; **PS-** posterior stroke; **R&PCS-** retrospective and prospective cohort study; **RCR-** retrospective chart review; **RCS-** retrospective cohort study; **ROS-** retrospective observational study

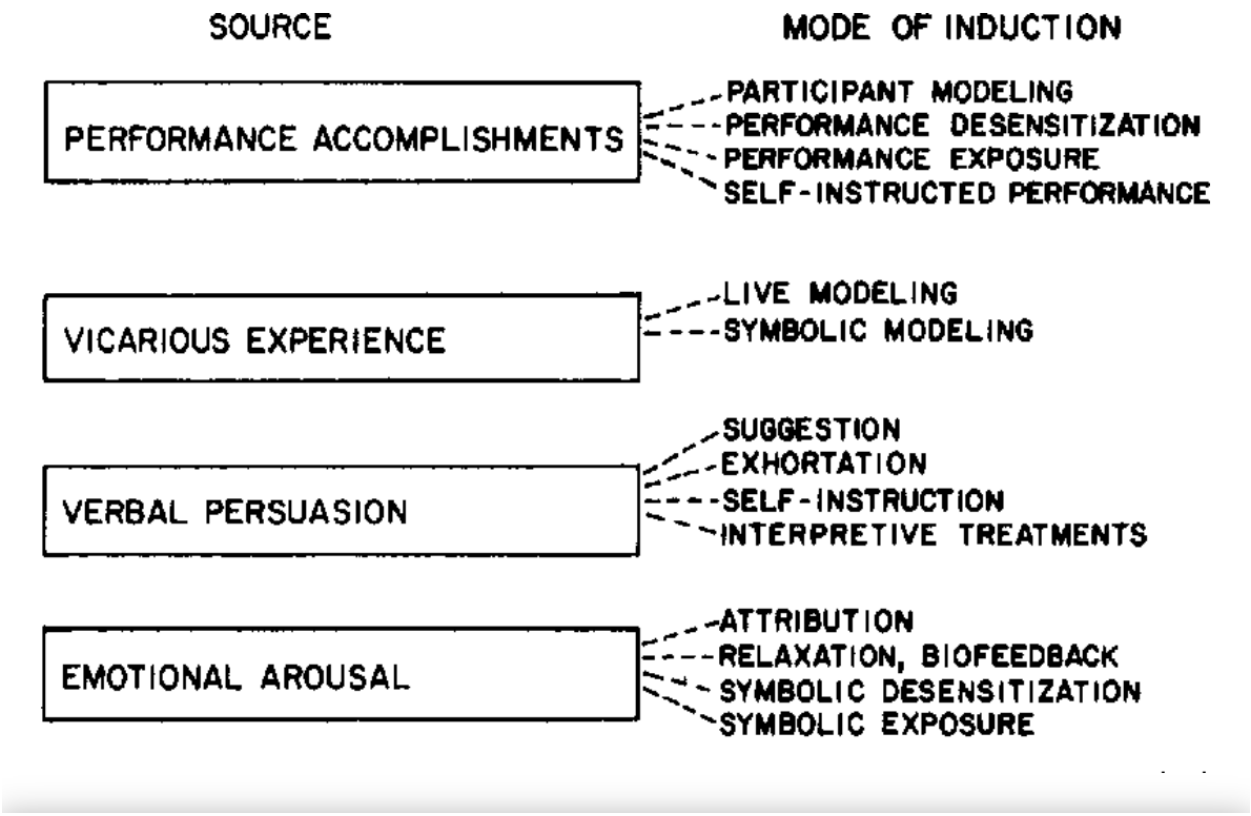
	Early stroke identification	•				•			•		•
	Location of occlusion in AIS		•						•		•
Findings	Misdiagnosis of AIS on initial presentation	•				•					
	CSs are consistent with LVO AIS		•						•		
	Decreased DTI time is associated with decreased long-term disability, H re-admission, and mortality			•	•			•		•	
	Dizziness is a reliable symptom in diagnosing PSs						•				•

Key: **AIS-** acute ischemic stroke; **CS-** cortical symptom; **DTI-** door-to-intervention; **H-** hospital; **LR-** low risk; **LVO-** large vessel occlusion; **MA-** meta-analysis; **OS-** observational study; **PH-** pre-hospital; **PS-** posterior stroke; **R&PCS-** retrospective and prospective cohort study; **RCR-** retrospective chart review; **RCS-** retrospective cohort study; **ROS-** retrospective observational study

Appendix C

Self-Efficacy Theory

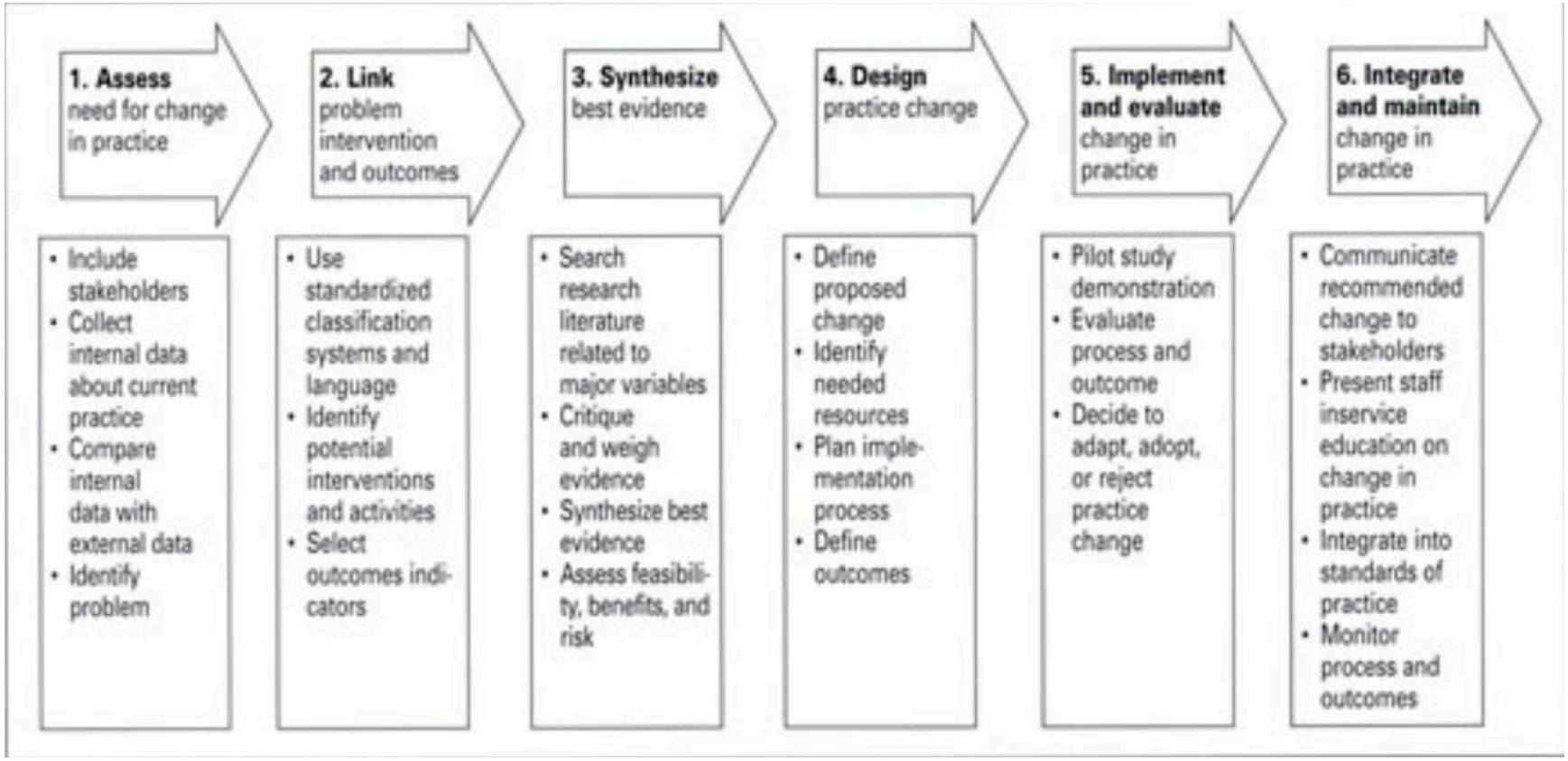
Figure 1



Appendix D

A Model for Evidence-Based Practice

Figure 2



Appendix E

Budget Plan

	Activity/Item	Cost	Subtotal
	Equipment for creating educational video and brochure	-$1,100 (already own)	**-$1,100**
Indirect Cost	Staff time at mandatory meeting (10 minutes, average pay ~$40/hour, ~60 staff members)	-$400.00	**-$1,500**
	Stakeholders time in preparation for project implementation	-$500.00	**-$2,000**
	Stroke coordinators time gathering and de-identifying data	-$100.00	**-$2,100**
Funding	Banner Health	+$1,000	**-$1,100**
	Personal	+$1,100	**$0.00**
Potential Revenue/Cost Savings	Decreased door-to-IR times supports quicker reperfusion, which is associated with better functional outcomes in patients and decreased rates of hospital re-admission. This results in a financial savings for the patient. For the organization, decreased door-to-IR times supports re-certification as a comprehensive stroke center and overall better hospital ratings. This makes them an ideal hospital to seek stroke care and increases patient volume which results in increased revenue.		

Total: $0

Appendix F

Minutes Pre-Education *(average)*	Minutes Post-Education *(average)*	Minutres reduced Pre vs Post *(average)*	% reduction in minutes (pre vs post)
105	77	28	27%