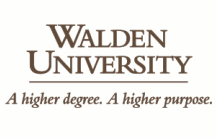

2019

Effective Strategies for Recognition and Treatment of In-Hospital Strokes

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This is to certify that the doctoral study by

Maryika Gibson

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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2019

Abstract

Effective Strategies for Recognition and Treatment of In-Hospital Strokes

by

Maryika I Gibson

MS, Washington State University, 2008

FNP, Post-Masters, Gonzaga University, 2014

BS, Washington State University, 2006

Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Nursing Practice

Walden University

May 2019

Abstract

In-hospital onset strokes represent 4% to 20% of all reported strokes in the United States. The variability of treatment protocols and workflows as well as the complex etiology and multiple comorbidities of the in-hospital stroke subpopulation often result in unfavorable outcomes and higher mortality rates compared to those who experience strokes outside of the hospital setting. The purpose of this project was to conduct a systematic review to identify and summarize effective strategies and practices for prompt recognition and treatment of in-hospital strokes. The results of the literature review with leading-edge guidelines for stroke care were corelated to formulate recommendations at an organizational level for improving care delivery and workflow. Peer-reviewed publications and literature not controlled by publishers were analyzed. An appraisal of 24 articles was conducted, using the guide for classification of level of evidence by Fineout-Overholt, Melnyk, Stillwell, and Williamson. The results of this systematic review revealed that the most effective strategies and practices for prompt recognition and treatment of in-hospital strokes included: staff education, creating a dedicated responder team, analysis and improvement of internal processes to shorten the time from discovery to diagnosis, and offering appropriate evidence-based treatments according to acute stroke guidelines. Creating organizational protocols and quality metrics to promote timely and evidence-based care for in-hospital strokes may result in a positive social change by eliminating the existing care disparities between community and in-hospital strokes and improving the health outcomes of this subpopulation of strokes.

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Section 1: Nature of the Project

Introduction

Stroke is a medical emergency, and patients' outcomes depend on immediate transportation to and treatment in a hospital with available resources and expertise in managing the acute phase of it. Since 2007, the American Heart Association (AHA) and American Stroke Association (ASA) has published multiple editions of its guidelines for acute treatment of stroke. These guidelines specify the successful components of systems of stroke care: prevention, community stroke education, optimal use of emergency medical services (EMS), effective acute and subacute care, rehabilitation, and performance reviews of stroke care at regional and state level (Powers et al., 2018). The AHA/ASA guidelines have become the foundation for collaborative work between hospitals and EMS providers as well as other community organizations (i.e., fire and rescue departments, ambulance services, city-subsidized emergency transportation services, etc.) in bringing well-organized services to communities across the United States.

Approximately every 40 seconds, someone in the United States has a stroke (Centers for Disease Control and Prevention [CDC], 2017). By 2030, an additional 3.4 million adults aged > 18 years will have had a stroke, representing a 20.5% increase since 2012 (Benjamin et al., 2018). According to the above report, while overall mortality has decreased, the morbidity and the related cost of the disease have been on the rise. The projections estimate that the total cost of stroke will rise from $40.1 billion in 2013 to 2014 to $81.1 billion for non-Hispanic Whites, $32.2 billion for Blacks, and $16.0 billion

for Hispanics causing an increase in direct medical cost to a total of $129.3 billion (Benjamin et al., 2018). Due to continuous cuts in reimbursements and an increasing cost of operations in the current health care environment, hospitals could become the primary centers for the projected increases. Existing clinical care delivery and organizational stroke protocols should be evaluated regarding their conformity to current evidence-based practices (EBP) as well as cost and value-based outcomes.

Problem Statement

A stroke event can happen anywhere - in any social or physical environment. Patients admitted to the hospitals for another disease exacerbation or different medical emergencies also suffer strokes. Depending on the time of onset and symptom's presentation, these patients may be eligible for thrombolysis treatments or advanced neuro-interventions, such as thrombectomies. There is limited extant research focused on the approach to treatments in this specific population. A lack of guidelines, the variability in the approach to the development of individual institutional protocols for the recognition of symptoms and treatment of those patients, and their heterogeneous risk factors have led to a potential under recognition and possible undertreatment of in-hospital strokes (Cumbler et al., 2014). The patient facilities need a multidisciplinary approach and highly coordinated care by providers who are familiar with the assessment tools and the latest guidelines to receive the benefit of the current advances in stroke care.

While most of the stroke patients in the United States are admitted to medical centers via EMS and other community agencies, a limited number of studies reported about 4% to 20% of all strokes occurring in already hospitalized patients (Cumbler et al.,

2014; Ho et al., 2016). Stroke is the fifth leading cause of death in the United States with an estimated annual cost of $34 billion based on 2016 data (Centers for Disease Control and Prevention [CDC], 2017). Data on in-hospital strokes (IHS) has been a subject to voluntary reporting and in the past, and has not been consistently separated from the data on community strokes. With the overall rising cost of health care and reduction in reimbursements, a more precise classification and monitoring of stroke events in already admitted patients will help the identification of improvement opportunities at the patient (i.e., individual) and hospital (i.e., organizational) level as well as in providing appropriate and cost-effective care to this subpopulation of stroke survivors.

In 2010, the National Stroke Association (ANA) in collaboration with ASA created a tool kit for providers taking care of in-hospital stroke patients (ASA, 2017). The area of ischemic and hemorrhagic cerebral infarcts in already hospitalized patients has been a subject of limited research. Nevertheless, since 2010, few published articles have focused on the analysis of care gaps and attempts at an individual and organizational level to improve patients' outcomes. According to the currently available literature, an in-hospital onset of new neurological deficits leads to delays in appropriate care provision, lower rate of thrombolysis (as a standard of care for ischemic cerebral events), longer hospitalizations, and more disabilities on discharge when compared to community onset strokes (Natteru et al., 2016; Saltman, Silver, Fang, Stamplecoski, & Kapral, 2015).

As a stroke nurse practitioner (NP) in a 350-bed facility in the northwestern United States, I participate daily in the care of IHS patients. In 2017, the stroke manager of the medical center reported about 12% in-hospital onset strokes from the composite

number of stroke cases for the facility. Patients' and providers' needs are not systematically assessed, evaluated, and included in quality improvement initiatives. To improve the care and patients' satisfaction with the Comprehensive Stroke Center (CSC) and to continue maintaining our recertification as such, current EBP and stroke guidelines need to be translated into daily clinical care by providers and institutionalized.

Purpose Statement

The purpose of this systematic review (SR) was to identify and summarize the most effective currently available strategies and practices for early recognition and prompt treatment of in-hospital onset strokes at the individual (i.e., patient) and organizational level. The results were then correlated to the recent guidelines for acute cerebrovascular disease (ACVD) issued by the AHA/ASA in 2018. Through a well-defined selection flowchart, such as Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Liberati et al., 2009), I describe the selection process and determination for the studies included in the analysis. Based on the synthesis of the published findings the project answers the following questions:

1. What is the current evidence related to identification and management of in-hospital stroke patients?
2. Based on the conducted SR, what recommendations should be presented to the hospital administration to address identification and management of in-hospital stroke patients at the facility?

The current SR could draw attention to and help identify factors influencing stroke outcomes at the provider and system level as well as serve as a vehicle for further

workflow improvements. The findings of the SR could also generate transformative processes and result in an uptake of new therapies and technology in stroke care. The results of the current review could become an enabling factor in the process of seeking institutional support in delivering the right therapies to the appropriate patients at the correct time.

Nature of the Doctoral Project

This doctoral project took the form of a SR of the current literature on the topic of in-hospital strokes. I reviewed extant articles on the topic, graded them on their quality, summarized their results, and made the SR available to specialists and providers involved in the care of stroke patients. I conducted the SR according to methodologies outlined in the *Manual for Systematic Review of the Doctor of Nursing Practice (DNP) Scholarly Project* (Walden University, 2017).

While multiple public and organizational initiatives as well as continuously updated editions of guidelines for early treatment of ischemic and hemorrhagic stroke have attempted to improve the overall workflow and patients' outcomes, only a limited discussion has taken place in the field regarding the subpopulation of stroke survivors affected by the disease while hospitalized for another condition. In this SR, I sought sources of evidence of effective approaches in addressing the problem under study through high-quality, peer-reviewed publications and the adoption of a widely accepted methodology. The methodology included the following features, as listed by Aromataris and Pearson (2014):

- Clearly articulated objective and questions to be discussed;

- Inclusion and exclusion criteria determining the selection of the studies;
- A comprehensive search to identify all relevant publications and application of selection standards, such as the PRISMA flowchart;
- Description of relevant publications from the unpublished sources, conference proceedings, dissertations, and other gray literature;
- Appraisal of the quality of the included studies and reported exclusions based on insufficient data or inferior quality;
- Analysis of the data from the included research;
- Synthesis of the findings; and
- Transparency in describing the process of performing the SR.

I identified the journal articles included in this project through the following computerized databases: Cumulative Index to Nursing and Allied Healthcare Literature (CINAHL), Pub-Med, Cochrane, MEDLINE, and available dissertation databases including publications between 2008 and 2018. Originally, I intended to include additional articles beyond the defined period if they were considered pertinent to the topic along with the rationale for the inclusion. However, through the review of the reference lists of the publications, I was unable to identify such resources. Articles describing concepts related to stroke care prior to 2008 were incorporated in the body of the SR.

The inclusion criteria consisted of articles with subjects having a diagnosis of a stroke while hospitalized for another disease, quality improvement initiatives and therapeutic interventions for in-hospital onset strokes, quality metrics for stroke care, and

stroke outcome measures. The articles included only adult patients of both sexes, aged greater than 18 years old. In addition, the authors of the publications examined medical interventions, quality metrics for CSC, and workflow elements for ACVD with an in-hospital onset. Key terms that I applied to the search were: *in-hospital stroke; secondary stroke; in-hospital onset stroke; adults; code stroke; rapid response team (RRT); stroke; thrombolysis; thrombectomy; tele-neurology; tele-medicine; length of stay; stroke severity; patient outcomes; complications (i.e., bleeding, hemorrhagic transformation, embolic event, and death); disposition;* and *discharge destination*.

My appraisal of the selected studies followed the Melnyk and Fineout-Overholt criteria for a hierarchy of evidence, answering the following questions:

1. Why was the study done?
    - Was there a clear explanation of the study and if so, what was it?
2. What is the sample size?
    - Were there enough people in the study to establish that the findings did not occur by chance?
3. Are the instruments of the major variables valid and reliable?
    - How ere the variables defined? Were instruments designed to measure a concept validity (did they measure what the researcher said they measured)? Were they reliable (did they measure a concept the same way every time they were used)?
4. How were the data analyzed?

- What statistics were used to determine if the purpose of the study was achieved?

5. Were any untoward events during the study?
    - Did people leave the study, and if so, was there something special about them?
6. How do results fit with the previous research in the area?
    - Did the researchers base their work on a through literature review?
7. What does this research mean for clinical practice?
    - Is the study purpose an important clinical issue? (see Fineout-Overholt, Melnyk, Stillwell, & Williamson, 2010, p. 49)

Significance

Quality of care is one of the top priorities for the health care system in the United States (The National Academies of Sciences, Engineering, and Medicine, 2019). The currently evolving landscape of health care requires clinicians and hospital leadership to focus on variances in care delivery, expenditures, and high-quality performance as measured by multiple, publicly reported, quality indicators (Agency for Health Care Research and Quality [AHRQ], 2018). Failure to apply current research into practice at the point of care or address knowledge translation in care decision-making and workflow processes has the potential to result in further variations in interventions, a greater waste of resources, and missed opportunities to improve the health of our hospitalized patients.

The American Colleges of Nursing (AACN, 2018) defined nursing scholarship as "the generation, synthesis, translation, application, and dissemination of knowledge that

aims to improve health and transform health care" (p. 2). Advanced practice nurses (APNs) are expected to enhance clinical practice through their scholarship skills (AACN, 2006). The scholarship of nursing practice at the point of care is one of the examples of undertaking an evidence-based approach to important patient-related issues and building competencies as future healthcare leaders (AACN, 2006). Conducting SRs, such as this project, synthesizing research findings and formulating solutions to current clinical issues is an integral part of engaging in the scholarship of practice and nursing leadership at the individual (i.e., patient) and organizational level (i.e., hospital or other health institution).

The analysis of current approaches of in-hospital onset ACVDs represents the first step of evaluating the existing quality of our clinical practice. The translation, the synthesis, and the dissemination of the results from an ethically conducted SR should become the foundation of knowledge translation and facilitation of research uptake into healthcare service delivery. Applying the new guidelines for treatment of acute stroke (Powers et al., 2018) and the successful examples of EBP implementation in other hospitals in the subpopulation of in-hospital strokes should influence enhancing current (and building future) systems of high quality, effective, and efficient patient care. Moreover, abandoning practices based on tradition will facilitate the improvement of the quality of life of stroke survivors and the reduction of the socioeconomic burden of stroke in the United States. The results of this review could provide a framework for the implementation of science interventions (or knowledge translation) to clinicians, health care administrators, hospital managers, quality improvement specialists, program leaders,

disease coordinators (e.g., stroke coordinators), and APNs involved in the care of patients with an in-hospital onset of ACVDs.

Summary

Stroke is a medical emergency, and patients' outcomes depend on immediate transportation to and treatment in a hospital with available resources and expertise in managing the acute phase of it. With a projected rise of 20.5% in prevalence by 2030, and a staggering direct medical cost of $94.3 billion in direct medical care (Benjamin et al., 2018), stroke as a disease will continue to place a high social and economic burden on the American health care system. As primary centers for the projected financial increase, hospitals should align their current protocols and clinical practices with EBP and research in the domain of in-hospital onset ACVDs.

The goal of this SR was to synthesize the presently available evidence related to identification and management of in-patient strokes. Recommendations to address the gaps in practices and possibilities for improvement based on the current review were presented to hospital leadership and disseminated to providers and organizations involved in the care of this stroke subpopulation. Stakeholders who could benefit from the results and conclusions of the SR include multiple specialty providers in the clinical setting, quality improvement specialists, program coordinators, and unit managers who could implement better strategies for care coordination, develop and validate knowledge translation interventions, and establish future research agendas. Section 2 of this project addresses the theoretical framework and my motivation for selecting the current topic. In addition, definitions and local context are clarified.

Section 2: Background and Context

Introduction

One of the goals of Healthy People 2020 is to "…increase the proportion of patients with heart attacks or strokes who receive artery-opening therapy as specified by current guidelines" (U.S. Department of Health and Human Services, 2018, para 1). In addition, Heart Disease and Stroke Goal 3 of the same document aims at the reduction of overall stroke deaths (U.S. Department of Health and Human Services, 2018). For the last 10 years, public awareness and education regarding stroke symptoms and immediate access to medical centers capable of acute treatment of stroke have been the main messages of multiple campaigns by AHA/ASA and the Brain Attack Coalition in communities across the United States (AHA/ASA, 2017; Brain Attack coalition, n.d.). The result of this effort was the creation of an organized, prehospital health care or stroke systems of care model, introduced in 2005 by the AHA/ASA and addressed in every edition of their stroke clinical guidelines (AHA/ASA, 2017). The above mentioned starts in the community or "in the field" with the involvement of EMS and other community-sponsored organizations and outlines clear protocols and coordinated strategies of delivering the stroke victims to appropriate medical centers with needed resources for their treatment (Powers et al., 2018).

While much of the focus has been on recognition of stroke by the public and its timely treatment in appropriate stroke designated or certified centers, less attention has been given to patients who suffer new neurological deficits while hospitalized for another acute condition. The 2010 toolkit, developed by the National Stroke Association in

collaboration with AHA/ASA, is designed to attract the attention of clinicians and hospitals concerning this subpopulation of stroke patients (American Stroke Association, 2017). Unfortunately, since 2010, few publications on the topic have highlighted the importance of the same urgency and need of organizational effort in treating IHS as the community onset ones (Cumbler at al., 2014; Kassardjian et al., 2017; Saltman et al., 2015).

Concepts, Models, and Theories

Hospitals and health care organizations can be classified depending on their function, ownership, or type of services they offer to the community. Despite the differences in the classification, health care institutions share one common characteristic: They can be viewed as complex organizations. A distinguishing feature of such complex organizations is that the interactions within the system cannot be reduced to the behavior of its units (or components) or viewed as a sum of those units (Reiman, Rollenhagen, Pietikainen, & Heikkila, 2015).

Complex adaptive systems (CAS) theory is a comprehensive framework dedicated to studying and elucidating the behavior of complex organizations (Tulder & Nienke, 2018). It seeks to formulate interaction based-rules for the individual entities that constitute the complex structure and through them explain the behavior of the organization as a whole (Reiman et al., 2015). CAS is grounded in systems and organizational change theories; however, it offers a more dynamic view of professional institutions and supports changes through highly adaptive approaches and partnership formations via double- and triple-loop learning and evaluations (Tulder & Nienke, 2018).

Individual programs in the hospital environment are considered separate entities; however, they interact continuously with each other, adjust according to political and economic environmental conditions (within and outside the individual hospital), and influence each other through learning and partnership reconfigurations. The stroke program in the hospital study site cannot survive without the collaboration of multiple internal medicine providers; emergency department (ED) clinicians; other specialties programs (i.e., cardiology, radiology, social services, transitional care etc.); administration; and community organizations. Therefore, the application of CAS theory reflects the hospital's functional environment and offers valuable concepts as a theoretical framework for the development of process changes based on a SR of the literature with a focus on in-hospital onset of stroke.

Definitions

Code Stroke Rapid Response Team (or RRT Stroke): An activation of RRT in response to a patient presentation with neurological deterioration of symptoms of ischemic or hemorrhagic stroke. A team of clinicians who bring critical care expertise to the bedside when a patient condition is deteriorating (Institute for Healthcare Improvement, 2001).

Community stroke (or pre-hospital onset stroke): A stroke event triaged or diagnosed based on their symptoms in the community setting (or in the field) with the involvement of EMS or in patients transported and admitted with stroke symptoms through the ED of a hospital (AHA, 2016).

Complications (or harmful events): An unanticipated event cause by medical (or surgical) treatment that may prolog hospitalization, produce disabilities, and requires additional monitoring or treatment (AHRQ, 2019).

In-hospital stroke: A stroke event diagnosed in hospitalized patients while they are receiving treatment for an acute disease or exacerbation of a different health issue (Cumbler, 2015).

Outcome: Evaluation undertaken to assess the results or consequences of management and procedures used in combating disease in order to determine the efficacy, effectiveness, safety, and practicability of these interventions in individual cases or series (National Center for Biotechnology Information, 1992).The outcome for this review was measured at the time of discharge from the hospital by valid instruments such as National Institute for Health Stroke Scale (NIHSS) or modified Rankin Score (MRS).

Tele-neurology: A division of telemedicine offering consultations and assessments from a remote location via teleconferencing using telephone or internet (eVisit, 2018).

Thrombectomy: Revascularization by a mechanical disruption or removal of thrombi or emboli occluding an intercranial or extracranial blood vessel (University of Pennsylvania Medical Center, 2015).

Thrombolysis: The dissolution of a thrombi or emboli in an intercranial blood vessel through the application of intravenous alteplase (or other pharmacological agents) according to the published indication for administration of the medications (Society for Vascular Surgery, n.d.).

Stroke: A syndrome caused by damage of cortical tissue due to occlusions of blood vessels supplying vascular territory of the brain, emboli dislodged from other blood vessels, or hemorrhage due to rupture of cerebral blood vessel (ASA, n.d.).

Relevance to Nursing Practice

The Brain Attack Coalition, formed in the late-1990s, has shaped stroke care through its multiple members and publications on rapid detection and early treatment of ischemic stroke (Brain Attack Coalition, n.d.). One of its major contribution to the improvement of patient care is its recommendations on the structural organization of stroke care (Alberts et al., 2000). The coalition recommended development of designated stroke centers offering organized stroke care 24 hours a day (Alberts et al., 2000). Based on these recommendations, certification agencies, such as the Joint Commission (2018) and Det Norske Veritas (DNV; 2017), developed minimal sets of structural requirements and performance measures for acute stroke-ready hospitals, Primary Stroke Centers (PSCs), and CSCs.

According to both certification agencies, the Joint Commission (2018) and DNV (2017), CSCs should be able to meet minimum volume requirements for specific stroke subpopulations, have advance neuroimaging 24 hours a day/7 days a week, have a dedicated neuro-intensive care unit, have a peer-reviewed process for reviewing patient complications, participate in stroke research, and demonstrate performance improvement beyond the PSC metrics. An additional requirement for the CSC is having an APN or NP as a member of the multidisciplinary team of providers taking care of stroke patients (DNV, 2018, The Joint Commission 2018). Stroke APNs and NPs have different roles

and functions depending on their expertise and the needs of the individual organization; however, their involvement in the acute phase of stroke care and quality improvement initiatives is universal.

APNs and NPs are expected to improve patient care through a development of enhanced leadership and scholarship skills, among them the scholarship of discovery (or scientific inquiry) and the scholarship of practice (AACN, 2006). The ability to critically appraise the latest research in nursing and medicine assists nurses in transforming their care delivery and improving patients' outcomes (AACN, 2006). Understanding current changes in stroke care delivery, decreasing length of stay, minimizing complications, and improving the quality of life of stroke patients at the point of direct care will demonstrate contributions of nursing to the needed care transformation of in-hospital onset stroke survivors. In reviewing the literature for the SR, I focused on peer-reviewed studies as well as publications from the gray literature on the topic of ACVD in hospitalized patients.

The development of new practice approaches and their implementation in a complex environment, such as single hospitals or hospital systems, will require a leap from procedural and conceptual knowledge to metacognition and integration of quality improvement, systems and standards of care, practice guidelines, and analysis of cost-effective practice initiatives. APNs and NPs need to consider the care transformation and research utilization in the context of specific organizational cultures and populations. Ethically appropriate knowledge dissemination and application facilitates the uptake of research and improves population health, organizational workflows and effectiveness,

and enhances the scholarship of practice guiding the treatment of specific subpopulations, such as in-hospital stroke patients.

Early symptom recognition of ACVD in hospitalized patients, proper utilization of available specialty resources, the creation of interprofessional stroke teams across the continuum of care in medical facilities, the readjustment of organizational workflows, and the abandonment of ineffective practices will optimize care and create sustainable programs. The importance of this project for nursing practice resided in reflecting on a critical challenge in optimizing the care of patients with a specific disease condition, such as ACVD during their hospitalization. While identifying gaps in current knowledge, I intended to examine and summarize interventions at the individual (i.e., patient) and organizational (i.e., hospital) level that could assist nursing and medical staff in advancing patient care and strengthening their capacity for knowledge exchange; collaboration; and future, on-going, deliberate dialogue regarding the benefits of an evidence-informed approach to the care of the in-hospital stroke subpopulation.

Local Background and Context

While the context of this project has been my experience as a stroke NP in a CSC in suburban, Northwestern city, the issues surrounding early detection and treatment of in-hospital strokes exist in other centers throughout the United States. In an effort to reduce time-to-treatment in a nonprofit medical center, my practicum and the DNP project focused on the CSC's leadership and stroke program efforts to enhance knowledge translation and current research utilization in facilitating the uptake of research to existing clinical practices. As such, this SR can be viewed as an invaluable

resource for aligning EBP and organizational policies and procedure in the care of specific stroke subpopulations.

Role of the DNP Student

As a stroke NP, I participate in the acute phase of stroke patients in the CSC. Through the development of the SR, my goal was to appraise current available literature on the topic of the ACVD during hospitalization of patients with another acute health issue or exacerbation of a chronic condition. My doctoral project met the objectives of the DNP program because it is a manifestation of the scholarships of practice and discovery: The translation of research and utilization of evidence to advocate and improve the outcomes of an identified patient population. In addition, it allowed me to serve as a patient's advocate on review committees, so interprofessional teams can collaborate more effectively in adjusting current organizational practices.

My motivational factors for selecting the project were the clinical observations of delayed care and suboptimal outcomes in hospitalized patients who suffered stroke. In addition, the insufficient collaboration with other specialty providers and minimal utilization of technological advances, such as telemedicine and neuro-interventions, created my desire to become more involved in all aspects of development of institutional practice guidelines and protocols for hospital strokes and enhance collaboration of multiple departments and providers involved in their care. The SR presents an effective tool in providing information on interventions for managing in-patient stroke care and improving patients' outcomes. The results and my recommendations based on them can assist in reducing the overall length of hospitalizations, improving patient and family

satisfaction with the delivery of care in our CSC (versus other stroke centers in the area), improving collaborative interprofessional engagement and workflows, and applying knowledge translation to create sustainable patient- and organizational-level interventions. In Section 3, I will explain the methodology and the selection of articles, as well as the synthesis of the evidence.

Section 3: Collection and Analysis of Evidence

Introduction

The purpose of this SR was to evaluate the current level of knowledge related to in-hospital onset of stroke. The project included identifying effective strategies for early detection and treatment of ACVD in hospitalized patients from peer-reviewed journals and selected gray literature. In this section, I examine the practice-focused questions, the SR methodology, and the sources of evidence.

Systematic Review Methodology

SRs are considered an essential tool in providing up-to-date knowledge on evidence-informed practice for clinicians at the point of care as well as identifying unmet needs in the research community (Aromataris & Pearson, 2014). By providing summaries on previous research regrading a topic of interest, they can help guide changes in future nursing or medical interventions, abandon ineffective and wasteful practices, and improve quality of patient care. Their usefulness is in the transparency of their standardized methodology and unbiased synthesis of literature (Aromataris & Pearson, 2014). SR are conducted according to explicit and reproducible steps and enable the readers to assess the relevance of the presented evidence to the issue of interest (Aromataris & Pearson,2014).

Pati and Lorusso (2018) proposed a detailed list of sequential steps in conducting an SR in order to meet high quality standards and to be considered a robust level of relevant evidence. The authors' list demonstrated the conscientiousness required for the

development of the necessary magnitude and depth of knowledge on a subject and the needed transparency in the process:

1. Familiarization with the PRISMA framework.
2. Developing of the study question.
3. Forming a study team. I conducted this project with the assistance of an experienced librarian in searching the multiple databases. A second content expert was identified to review my findings.
4. Identifying the concepts of interest.
5. Defining the individual terms in the study question(s).
6. Selecting databases relevant to the topic area (minimum one and typically no more than five).
7. Finalizing a plan for the systematic search (this step should include developing key words used for the search).
8. Deciding on inclusion and exclusion criteria.
9. Tailoring key words to each data base search.
10. Conducting the actual database search.
11. Organizing database results.
12. Reviewing the abstracts and phase screening for quality checks.
13. Updating the PRISMA flowchart through the process.
14. Critical review of full text articles and quality checks.
15. Developing a matrix of included studies.

The PRISMA statement contains 27 items and a four-phase flow diagram regarding the different stages of the SR process (Liberati et al., 2009). Appendix B displays the number of identified records, excluded articles, and the included studies. By incorporating the PRISMA checklist and utilization of the explanatory document by Liberati et al. (2009), I intended to reduce the bias of conducting a single author SR and provide a helpful translation of current evidence on the topic on in-hospital onset strokes.

Practice-Focused Questions

1. What is the current evidence related to identification and management of in-hospital stroke patients?
2. Based on the conducted SR, what recommendations should be presented to hospital administration to address identification and management of in-hospital stroke patients at the facility?

Sources of Evidence

To address the issues of timely detection and treatment of ACVD in hospitalized patients, I used the following databases: CINAHL, MEDLINE, EBSCOhost, ProQuest, and PubMed. In addition, the Cochrane database was reviewed for available SRs on the topic. Recommendations from the current AHA/ASA guidelines for the early management of patients with acute stroke (see Powers et al., 2018) and materials and position papers on The National Quality Measures Clearing House website were also included in the SR. I conducted a gray literature search through search engines, such as Google Scholar, The Gray Literature Report, and Mednar. I also explored dissertations on the subject through the international OpenThesis database as well as the Networked

Digital Library of Theses and Dissertations. Furthermore, the content of stroke-specific or disease-related publications, such as *Stroke* and *Neurology*, were scanned for peer-reviewed materials on in-hospital strokes and approach to their treatment. I also examined proceedings and presentations from the International Stroke Conferences in the last 10 years for relevance to my search.

Key Terms and Inclusion and Exclusion Criteria

The key terms I used in the search were: *in-hospital strokes, in-hospital onset stroke, secondary stroke diagnosis, code stroke, Rapid Response Team (RRT) Stroke, thrombolysis, thrombectomy, tele-medicine, tele-neurology, bleeding, hemorrhage, death, mortality, stroke severity, disposition, discharge destination, length of stay, stroke outcome measures, Modified Rankin Score,* and *National Institute of Health Stroke Scale (NIHSS)*. These terms were entered into Microsoft Word and checked for spelling errors that could have influenced and diminished the value of the results.

The time frame for the review was a period of 10 years, considering the rapid development of new technological advances in diagnosing and treating acute cerebrovascular events. If identified, landmark studies beyond the determined period were included in the analysis. With limiting the results to the last 10 years, I had the goal of gathering the most up-to-date publications reflecting application of recent neuro-interventional studies and the major changes in current stroke treatment guidelines.

To meet the inclusion criteria, articles had to: (a) be published between August 1, 2018 and January 1, 2008; (b) include the key words of in-hospital strokes, code stroke, stroke in hospitalized patients, interventions in in-hospitalized strokes, and outcomes of

ACVD as a secondary diagnosis during patients' hospitalization; (c) be available in full text; and (d) be published or available in the English language. Randomized controlled trials, quantitative studies, and observational studies were also included in the SR. In addition, the population was limited to adults aged 18 years old or older.

The exclusion criteria consisted of: (a) articles with results and outcomes on community onset stroke, (b) articles not in English language, and (c) articles on cerebral ischemic events in the pediatric population or patients aged less than 18 years old. Letters to the editors and opinion publications were excluded. I eliminated articles identified as republications of a previous report or study from my final list.

Analysis and Synthesis

I assessed publications using the results section of the PRISMA check list (see Liberati et al., 2009) and the Melnyk and Fineout-Overholt's criteria for hierarchy of the evidence (see Fineout-Overholt et al., 2010). Table 1 offers an explanation of the assigned levels of evidence; the highest levels of evidence are considered Level I through Level III, while the lowest are Levels VI and VII.

Table 1

Hierarchy of Evidence for Study Selection

Level of evidence	Study type	Description
I	Systematic review or meta-analysis	A synthesis from randomized controlled trials
II	Randomized controlled trial	A well-designed controlled trial with randomization
III	Controlled trial	An experimental study without randomization
IV	Case controlled and cohort study	A comparison or observation to determine characteristics or outcomes in subjects
V	Systematic review of qualitative or descriptive studies	A synthesis of evidence from qualitative or descriptive studies
VI	Qualitative or descriptive study	Answers questions regarding human behavior or provides background on topic of interest
VII	Expert opinion or consensus	A committee or authoritative opinion on a specific topic

Ethical Considerations

Due to a possible heterogeneity of studies selected for an inclusion in SR, Weingarten, Paul, and Leibovici (2004) advocated for an ethical assessment of every literature review. I conducted this SR based on publications with cumulative data sets without any patients' identifiers. Additionally, epidemiological data provided by my institution did not require an examination of individual patients' records. Walden University Institutional Review Board (IRB) approval was sought through a submission of preliminary ethics review form (Form A). The IRB approval number for the current study is 11-21-18-0674893.

I did not receive any financial support for this project and did not encounter any conflicts of interest to report. All selected publications were examined for author

disclosures regarding conflicts of interest and approval by local ethic committees as an evidence of compliance with the principles and provisions of the *Belmont Report* (U.S. Department of Health and Human Services, n.d.). In regard to international reports, I considered the reporting of ethical committee approval a conformity with the Declaration of Helsinki for ethically conducted research (World Medical Association, 2018).

Summary

In this section, I described the methodology, the practice-focused questions, the inclusion and exclusion criteria, and ethical consideration in my selection of studies on the topic of IHSs. Following the SR steps outlined by Pati and Lorusso (2018), I used the PRISMA flowsheet (see Liberati et al., 2009) and Melnyk and Fineout-Overholt's system for appraising the current level of evidence (see Fineout-Overholt et al., 2010). My goal with this project was to report the current state of knowledge regarding early identification and treatment of ACVD in patients hospitalized for an acute event or exacerbation of a chronic disease. The development of new technological advances, such as telemedicine, and the extension of the time window for neuro-interventions in appropriately selected patients enable providers involved in the care of stroke patients to revisit and improve current practices and institutional and stroke teams' workflows and, ultimately, the outcomes of their patients. This SR of in-hospital stroke studies was intended as a tool to be used in achieving this goal. In Section 4 I discuss the literature data analysis including the synthesis of the selected studies, the implications and recommendations for changes in the approach to IHS, and the strengths and limitations of the SR.

Section 4: Findings and Recommendations

Introduction

The purpose of this systematic literature review was to identify and summarize the most effective currently available strategies and practices for early recognition and a prompt treatment of IHS. Although the reported events of stroke in hospitalized patients varies between 4% to 20 of all documented strokes, their financial and social burden on society is very heavy (Farooq et al., 2008; Manawadu, Choyi, &Karala, 2014). There are numerous drivers for a new approach to managing this, including raising cost of healthcare services, the increase in the aging population, and implementation of value-based medicine.

I applied a building block search algorithm incorporating separate concepts of interest related to the subject of IHS. The results were joined together with a connector (i.e., AND). The technique allows the researcher to explore different aspects of the topic or change directions in the search without having to a duplicate long string of synonyms. An expect librarian reviewed the technique and confirmed the results. The first block of search terms was: *in-hospital stroke* OR *secondary stroke* OR *in-hospital onset stroke* OR *code stroke* OR *Rapid Response team stroke*. The second block consisted of *thrombolysis* OR *thrombectomy* OR *teleneurology* OR *tele-neurology*. Next, a search for: *bleeding* OR *hemorrhage** OR *emboli** OR *death* OR *mortality* OR *length of stay* OR *stroke severity* OR *disposition* OR *discharge destination* was conducted. The combined concept blocks were connected with AND. The result was a total of 1,026 articles. After removal of duplicates and reviewing abstracts for my preset inclusion criteria, I narrowed down the

search to 147. Twenty-four articles met all the inclusion criteria. The analysis of selected articles was based on Melnyk and Fineout-Overholt's criteria for a hierarchy of evidence (Fineout-Overholt et al., 2010).

Section 4 consists of the evaluation and synthesis of the articles selected for the systematic review of literature. In it, I provide a report on the methods of identifying the appropriate research articles through the application of the selected inclusion and exclusion criteria. The search was accomplished with key terms, limited results to English language, full-text articles, and peer-reviewed journals. There were no articles Level I, II, or III, but there were 14 for Level IV, one for Level V, and nine for level VI. Table 2 summarizes the results. The complete literature review table may be found in Appendix A. The articles are broken down and grouped according to the level of evidence. Their strengths and limitations are discussed in this section along with the resulting implications for nursing practice and further research.

Table 2

Hierarchy of Evidence for Selected Studies

Level of evidence	Study type	Studies *N*
I	Systematic review or meta-analysis	0
II	Randomized controlled trials	0
III	Controlled trials without randomization	0
IV	Case controlled trials and cohort studies	14
V	Systematic review of qualitative or descriptive studies	1
VI	Qualitative or descriptive studies	9
VII	Expert opinions or consensus	NA

NA – not applicable – category not included

Findings and Implications

The evidence for in-patient strokes is not very strong, but appropriate. Level II and III studies are difficult to conduct in a hospital setting because it may be unethical to randomize patients to an experiment and not provide the latest available technology and care advances appropriate for their condition (World Medical Association, 2018). No Level I or SRs of randomized, controlled trials on the topic were reported in the current literature. Level IV studies were retrospective, cohort studies utilizing large systems or individual hospital registries. The gray literature, accessed through a Mednar search, offered one Level V narrative review of current studies on patients who had IHS. Level VI were descriptive studies of educational or response team initiatives implemented in individual institutions with the goal of improving the quality of patient care. All studies were ethically conducted and disclosed no conflicts of interests, speaking arrangements for pharmaceutical or device companies, and approval of Institutional Review Board. The authors of the publications (except for three of them) acknowledged the limitations of their studies as small samples, individual institutions, variability of patient populations, limited hospital resources, multiple data points missing in the reporting, and possible underreporting of the number of patients identified as having acute cerebrovascular disease (ACVD) event while hospitalized for other emergencies and acute exacerbations of other conditions.

The intent of the review was to examine currently available strategies and practices for early recognition and timely treatment of in-hospital onset strokes at the individual and organizational level. Four subthemes emerged from the review: (a) the

importance of hospital-wide staff education regarding early recognition of stroke symptoms, (b) bringing a specialized team to the stroke patient, (c) currently existing discrepancies between standards of care and quality metrics for community stroke and the lack of such in hospital onset strokes, and (d) inefficiencies in hospital workflow preventing delivery of timely care to the subpopulation of patients having ACVDs while admitted for a different diagnosis. The results of the SR may help in raising awareness regarding the application of new guidelines and technologies in improving the outcomes of these patients. In addition, it could help identify factors in improving workflow deficiencies and stimulate uptake of current research and therapies into the care delivery of IHS.

Level IV Studies

Bhalla, Smeeton, Rudd, Heuschmann, and Wolfe (2010) analyzed 291 IHSs and compared their characteristics and outcomes to 2,111 COS from a city-wide registry. The number of hospitals was not included in their study, and therefore, it was difficult to estimate variations in the percentage of patients having ACVDs between the individual organizations. Specifics of the hospital environments or type of hospitals and resources were not described in their study. The authors reviewed results of follow-up data on patients' outcomes 3 months posthospital discharge. The mean rate of IHS was 11%, and patients' characteristics included history of arrhythmia, hypertension, and acute myocardial infarction (Bhalla et al., 2010). Patients who suffered stroke during their hospitalization had a significantly longer length or stay -55.9 days vs. 37.9 for patients admitted through the EDs (Bhalla et al., 2010). Their study confirmed that patients with

IHS had poor access to a number of components of stroke care, such as being less likely to undergo imaging with an *OR* = 0.54, 95% *CI,* and *p* = 0.015; being less likely to be treated on a stroke unit with an *OR* = 0.33, *CI* = 95%, *p* < .001; or prescribed antiplatelet therapy with an *OR* = 0.51, *CI* = 95%, and *p* = 0.015. Strokes identified during the hospitalization had higher percentage of motor, sensory, and dysarthria deficits when compared to the rest of the stroke patients and were more likely to be discharged to nursing facilities (Bhalla et al., 2010). The authors recommended implementation of policies and guidelines as well as evidence-based pathways that prioritize the needs of those patients be developed at a hospital level, which could improve the inequality of stroke care between the two populations.

Caparros et al. (2017) reviewed a single center data registry comparing interventions and outcomes between IHS and COS. The reported rate of stroke identified during the patients' hospitalization was 5.2% during a period of 13 years (2006 to 2016) with an *N* = 1,209 cases (Caparros et al., 2017). In their study, they analyzed the severity of strokes in both populations by NIHSS, which was similar (a median of 12 in IHS vs. 11 in COS) and patients' outcomes at 3 months. Caparros et al. are the only authors reporting a treatment of patients with ACVD while hospitalized by 17 minutes faster than the rest of the strokes and no difference in the outcomes. Their patients with hospital onset stroke had a very favorable outcome at 3 months with an MRS of 0 to 3 at 73%, or having no deficits (0), a mild deficits and ability to function independently (1 or 2), and able to walk on their own (3). In the COS group of their study, the same scores were at 85%. The death rate in IHSs was 23% vs. 15% in COS (Caparros et al., 2017). The

researchers confirmed that improvements in patients' outcomes are possible and should become a priority in our health care system. They emphasized that a reduction of delays in care, early recognition of stroke at risk departments (i.e., cardiac and surgical units), and the level of experience in stroke care combined with stroke-specific clinical pathways are critical components of a desired improvement in a hospital setting.

In an analysis of the state-wide stroke registries of Colorado and Michigan, Cumbler (2015) documented IHSs imaging difference of 59 minutes between the IHS and COS groups (median of 98 minutes vs. 29 minutes with a $p < .001$), thrombolytics application of 31.6% vs. 73.4 % ($p < .001$), and an overall defect-free care 60.8% vs. 82.0% ($p < .001$). The author attributed the factors contributing to quality of care gaps into the following groups: difficulties in recognizing possible stroke symptoms, delays between onset of symptoms and assessment, delays in stroke evaluation, poor adherence to consensus measures of stroke process care quality during hospitalization, and transitions of care metrics not consistently followed. Cumbler acknowledged that variations of sample sizes, definitions of quality metrics, and trends toward improvements in adherence to stroke metrics make direct comparison of data from different centers difficult. The author suggested that organizations should focus on these areas for improvement by bringing a dedicated neurology team to the bed side, developing a process map for in-hospital strokes and specific report tools, as well as delineating responsibilities and standardizing the response steps.

In a cohort study of a state-wide registry maintained by the Colorado Stroke Allience, Cumbler at al. (2011) analyzed the severity and compliance to defect-free care

defined as an adherence to the quality metrics hospitals report in the Get With the Guidelines (GWG) national depository. The authors noted that patients suffering strokes while hospitalized had a higher NIHSS – 9.5 vs. 7.0 (p = .01), it took almost twice as long for their assessment or twice the benchmark of 25 minutes, and deficit-free care reported was higher for IHSs vs. COSs (52.8% vs. 32.3%, p < .001). They reported a better provision of care to patients suffering ACVD while hospitalized despite of delays in their assessment. The authors stated that some of the hospital did not report their IHS and these patients should be included in all GWG cases in the future so that the results can be analyzed and the gaps in the quality of care of all stroke patients can be removed.

In an analysis of national registry (i.e., the GWG), Cumbler at al. (2014) reviewed the severity of stroke and the quality of care (defined as quality measures entered in the GWG registry) to a combined population of 21,349 patients who had an ACVD while hospitalized. They reported that the median NIHSS for IHS was 9.0 vs. 4.0 for COS (p < .001) and the proportion of deficit-free care was lower for the same group – 60.8% vs. 82.0% (p < .001). Patients from the ISH group were less likely to be discharged home (OR = 0.37 with CI = 95%), be able to ambulate at discharge (a surrogate for MRS of 4 or higher) with OR = 0.42, CI = 95%, as well as have higher mortality OR = 2.72 with CI = 95%. The findings in their study contradict the results of the Colorado Alliance Registry study but were similar to those of the rest of the studies on ACVDs. The authors reported multiple missing data points and concluded the findings may be not generalizable to all stroke centers in United States. They recommended better reporting, decreasing the magnitude of differences in quality of care, and achieving target quality

metrics through development of stroke order sets, application of evidence-based care and in-hospital processes.

Emiru, Adil, Suri, and Quereshi (2014) performed a cohort study based on a nation-wide registry of 25,193 strokes identified while patients were hospitalized for another diagnosis. Although they did not find statistically significant differences between demographics and post thrombolytic complications for IHSs and COSs, the authors reported a higher rate of utilization of endovascular treatments for the first group – 9.6% vs. 6.1% ($p < .001$) and longer hospital stay 8 days vs. 7 for COS ($p < .001$). The authors reported missing data points and a wide variation of length of stay between different institutions. Recorded disabilities did not differ between the two groups; however, with a mean hospital cost of IHS was $74,714 vs. $68,429 for patients admitted through the ED. Mortality of acute ACVDs was $OR = 1.17$ with a $CI = 95\%$, and the authors stipulated that delays in detection and treatment of those patients led to the higher mortality. Mechanical thrombectomy was used more often in IHS (8.1% vs. 5.6%, $p < .001$); however, door-to-imaging (or detection-to-computer tomography [CT]) and CT-to-treatment times were significantly longer in the above group, with a mean of 39.5 minutes vs. 19.7 minutes for door-to-CT and 92.0 minutes vs. 65.4 minutes ($p < .001$). Recognizing the higher mortality and delays in care provision, the authors called for the development of in-patient code stroke teams and further efforts to improve the care of IHS population.

Farooq et al. (2008) performed a 6 months prospective cohort study of IHS and COS based on a statewide registry. They analyzed 177 cases with 68% of those patients

undergoing an invasive or diagnostic procedure prior to their in-hospital strokes. They found that the group had a higher case fatality (14.6% vs. 6.9%, $p < .04$, greater functional impairments (MRS= or > 4, 61% vs. 36%; $p = .001$ and were less likely to be discharged home (23% vs. 52%, $p < .01$). Only 3.1% of those patients received recommended imaging within 25 min of symptoms recognition, the length of stay in those patients had a median of 8 days vs. 4 days for COS. Although the quality of care was similar to both populations according to the authors, the lack of recognition of stroke symptoms was reported as a main reason for delays in needed care provision. Due to lack of detailed reporting of these cases (many data points were missing), the authors suggested a complete documentation and better reporting of in-hospital strokes, as well as developing a hospital-wide system of care that would help improve the outcomes of this population.

Manawadu, Choyi, and Karla (2014) performed a prospective cohort study in an academic hospital reporting a 4.6% incidence of ACVDs. About 80% of all strokes were recognized within 3 hr hours of onset of symptoms. Patients who were referred early for a neurology management had better outcomes at 90 days, $OR = 1.13$ with $CI = 95\%$. They did not report any difference in mortality between IHS and COS, and according to the authors, an early referral to a specialist was an independent predictor of a good outcome (or MRS of two or less) after adjustment for other variables. Additionally, 19% of patients would have been eligible for thrombolysis if their symptoms were discovered within the therapeutic window of 3 to 4.5 hr of onset. The authors highlighted the need

for implementing processes that create early recognition, referral and specialty management for patients with in-hospital onset (or secondary) stroke event.

Moradiya and Levine (2013) conducted a cross-sectional study to clarify the differences between risk factors and outcomes in patients who have an ACVD while in the hospital compared to community onset strokes. The reported rate of IHS was 8.7% of all strokes or 1,020 patients. Primary outcomes were favorable outcomes (or discharge disposition) and inpatient mortality. Secondary strokes were associated with a higher comorbidity profile and higher inpatient mortality- 15.7% vs. 9.6% ($p < .001$), as well as a lower rate of discharge to home or self-care -22.8% vs. 30.0% ($p < .001$). Moradiya and Levine concluded that IHS is a subpopulation of strokes that represents more severe stroke cases with overall poorer expected outcomes due to their co-morbid conditions and poorer baseline. The authors noted that the quality of their analysis is limited by missing data points and misclassification of IHS vs. COS due to current rules in census reporting Despite of IHS being a higher risk population at base-line, the rate of observed intracranial bleeds or complications after thrombolysis were similar for both groups- 4.7% in the COS group vs. 5.3% in IHS Moradiya and Levine concluded that when detected on time, thrombolysis is safe and feasible in this subpopulation of stroke patients.

Natteru et al. (2016) analyzed the differences between in-hospital ($N = 93$) and community onset strokes in a retrospective analysis of data from a large tertiary care center. They reported a median NIHSS of 10 and an average onset-to-time of evaluation 34.8 min, onset-to-treatment 236.6 min, onset to CT scan 67 min, evaluation to needle

213.8 min. Their analysis confirmed that the most common etiology of IHS was cardio-embolism (72%). The authors ascertained that IHS are more complex at presentation and that they have multiple and more severe comorbidities. The authors did not report the percentage of patients with a secondary stroke as a total of the hospitals stroke population. However, they identified as one of the limitations of their retrospective chart review the actual underestimation of the IHS number due to deficiencies in reporting of multiple data points. Natteru et al. suggested that in-hospital strokes are a common occurrence and in-depth knowledge of their risk factors will help in early identification and treatment of this population.

Park et al. (2009) reviewed data retrospectively in a single hospital investigating the frequency, relationship with specific procedures, risk factors, stroke mechanisms, mortality, and the cause of death in a cohort of 111 patients over 4 years in a university hospital. The most frequent IHS occurred in the department of cardiology and cardiovascular surgery representing 46% of all in-hospital events (Park et al., 2009). The timing of the ACVD was between 1 and 7 days of procedures. Length of stay for IHS had a mean of 30.1 days vs. 11.0 for COS with $p < .001$. Only 2.7% of patients with in-hospital onset stroke received thrombolysis, and on discharge, 57% of patients were ambulatory with an estimated MRS of less than 3. Patients with a secondary stroke diagnosis had a 10-fold higher mortality with a greater neurological severity (19% vs. 2%, $p < .001$). The authors excluded minor strokes from their study, thus acknowledging that their results represent an underestimated percentage of reported ACVDs. They called for an activation system focused on cardiac and cardiovascular surgery wards, a mobile

stroke team, and training of nursing and medical staff in recognizing early the symptoms of stroke.

Schuermann et al. (2016) conducted a retrospective cohort study in a single hospital reporting a 9.4% incidence of IHS with a mortality of 31.4% vs. 9.4% ($p < .001$) and length of stay of 19.5 days vs. 12.1 in COS ($p < .001$). Most strokes occurred in the departments of cardiology and cardiothoracic surgery (32% and 25.7%, $p < .001$) with ISH having higher severity by NIHSS than COS – 14.9 vs. 11.9 in COS. Symptoms to imaging was a median of 73.3 min vs. 30.9 min, symptoms to thrombolysis 84.9 min vs. 37.9 min, symptoms to angiography 124.2 vs. 91.8 min ($p <.001$) with 15.7% of secondary strokes receiving reperfusion therapy. The median of MRS of 2 or less at 90 days post discharge was 26% of in-hospital onset strokes vs. 41% of patients entering through the ED. The authors determined that the delays in diagnosis and treatment in IHSs were due to prolonged times in recognizing the stroke and higher acuity of those patients. They concluded that substantial number of strokes occur while patients are hospitalized that they are associated with higher mortality, worse outcomes, lower rate of reperfusion therapies, and worse functional outcomes when compared to the rest of the stroke patients. Schuermann et al. suggested training nursing and medical staff on specific units, such as cardiac and thoracic surgery in early recognition of stroke, implementing a standardized process of alerts and treatment options to reduce the delays in treatment and improve outcomes in patients with a secondary diagnosis of stroke.

In a retrospective cohort study Saltman, Silver, Fang, Stamplecoski, and Kapral (2015) reviewed data on patients admitted with a diagnosis different than stroke who had

a reported neuro-vascular event during their hospitalization. The sample size was 973 patients from 11 organizations with a primary outcome time from recognition to first neuroimaging procedure and secondary outcomes time from onset to treatment (thrombolysis), length of stay, MRS on discharge (outcome), discharge destination, and mortality at three-time intervals – 7 days, 30 days, and 1 year after the stroke. Their analysis confirmed that IHS had longer times of onset to neuroimaging (4.5 hours vs. 1.2, $p < .001$), lower rates of thrombolysis (12% vs 19% in COS), a longer length of stay (17 vs. 8 days, $p < .001$), and were more likely to be dead or disabled on discharge (an MRS between 3 and 6 in 77% vs .65% and $OR = 1.64$, $p < .001$). Mortality at 30 days and 1 year were higher in IHSs 22% vs. 18% and 25% vs. 25% ($p < .001$) compared to COSs. They emphasized that training all staff in early recognition and stroke detection, creating specific protocols for their treatment, and analyzing institutional factors in the delays that may remove the variations of care for the two stroke populations. Saltman et al. called for a standardized approach to recognition and management of ACVDs, the use of mobile stroke teams, and a development of code stroke protocols similar to the protocols utilized in ED for COS.

Vera et al. (2011) conducted a multicenter prospective cohort study based on data from 1 year of 273 patients with a secondary diagnosis of stroke in 13 hospitals from Spain. They compared data on demographics and clinical characteristics, quality of care, thrombolytic therapy and mortality of IHS and COS. While baseline demographics did not differ much between both groups, cardioembolic sources were the etiology of most patients diagnosed with stroke during their hospitalization (50.5%). Fifty two percent of

inpatient strokes were assessed by a neurologist within 3 hours on symptoms onset. About 15.7% received thrombolytic treatment, 14.7% could not be treated due to delays in contacting the neurologist, and 18.4% ($p < .001$) of IHS died due to complications during their hospitalization. The authors proposed educational programs for medical staff, targeting units at high risk such as cardiovascular or cancer departments, and improving hospital pathways in attempt to improve the outcomes of the sub-population of stroke patients.

Level V Studies

Chen, Singh, Kamal, and Hill (2018) conducted a narrative review of available studies with a focus on in-hospital strokes. Their timeline extended from 1996 to 2017 and the authors used a medical subject heading search with terms "stroke" and "inpatient" or "in-hospital" in the title of the articles. The review included six studies with a large population of $N = 38{,}965$ of IHS. The patients with a secondary diagnosis of stroke had a high rate of contraindications to thrombolysis-68% vs. 37% for COS and occurred most often on cardiology and cardiac surgery units. IHS had more comorbidities, particularly and a lower rate of treatment 9.1% vs. 16.8% ($p < .001$) in COS with a higher likelihood of receiving endovascular therapy versus thrombolysis (45.3% versus 10.4%, $p < .001$), therefore their stroke severity on detection of the event was higher although differences in NIHSS were not reported in both cohorts. The authors concluded that based on the limited literature organizations committed to improving their in-hospital onset strokes should focus on the following major areas: early recognition of stroke, proper activations of stroke teams, reduction of delays in imaging and diagnosis,

and reduction of treatment times. In addition, they suggested that establishing and utilizing existing IHS protocols may improve the quality of care for this sub-population.

Level VI Studies

Bunch, Nunziato, and Labovitz (2012) identified 79 cases of secondary diagnosis of stroke through a review of chart in a single hospital. They found that 18% of those patients did have a delay in diagnosis due to signs not being recognized on initial neurological examination or a diagnosis beyond three hours of symptom onset. The IHS had a higher NIHSS score with a median of 13 vs. NIHSS=5 for hospital admitted through the ED. The reported incidence of IHS was 16%. In 56% of these patients, a surgery preceded the onset of stroke with a reported cardiovascular intervention most commonly.

Additionally, 37% could have received thrombolysis if their symptoms were identified within the therapeutic window for thrombolysis. The failure to identify patients appropriate for therapy was one of the main modifiable factors in seeking an improvement in IHS care. The authors recognized some of the limitations of their study as coding errors and reporting biases, as well as missing data points in the reporting of IHS cases. They suggested training of the hospital staff in early detection of stroke symptoms as a method of improving the outcomes of this population.

Campello et al. (2015) implemented a training program for the medical staff in a single hospital and evaluated the results of their intervention. The project lasted 3 years, and as a result, they noticed a 68% on-time recognition of stroke in already hospitalized patients within 4.5 hours of onset of symptoms, 10% of patients underwent endovascular

therapy. Since the hospital was a comprehensive stroke center the study identified a good system for notification of new onset strokes in the hospital departments before the program implementation, so it was difficult to assess the size of the intervention effect. The authors reported some defects in the data collection. However, they suggested that well-defined protocols for care of those patients combined with staff education regarding early recognition of stroke symptoms can improve the outcomes of IHS patients.

Cumbler, Anderson, Neuman, Jones, and Brega (2010) implemented an RRT Stroke in a university center and analyzed its impact on the equality of care deliver to in-hospital onset strokes. The utilization of RRT Stroke was preceded by an extensive educational initiative on training staff to recognize signs and symptoms and the proper activation of the stroke team. After the intervention, the median time from symptom recognition to CT for IHS decreased from 271 min to 74 min ($p = .02$). Additionally, the use of thrombolysis increased from 8% to 20%. Despite of the improvements, the overall response time to in-hospital stroke alerts was slower than the stroke alerts in ED – 98 min vs. 29 min ($p < .001$). They concluded that RRT Stroke has an important role in the care of stroke patients who need fast diagnosis and treatment and suggested and when properly activated can improve the quality of care in ACVDs. Cumbler at al. suggested that further studies should investigate the application of treatments such as intraarterial application of alteplase and mechanical thrombectomy in this population.

Cumbler and Simpson (2015) described a quality improvement initiative to rapidly evaluate patients with new onset neurological symptoms developed during their hospitalization in six hospitals from different areas in the United States. The Primary

stroke Centers reported a total of 393 code strokes throughout 12 months. All the in-hospital alerts could be activated by any provider concerned that the patient may have a stroke. Responders consisted or RRTs with an additional training in stroke. According to the authors, most commonly an RN was one of the first responders. While 194 patients or 49.3% of the codes resulted in a confirmed diagnosis of stroke, the mimics reported by the individual institution ranged between 29.6% and 66.7%. The percentages of treated patients were: 8.2% with thrombolysis, 10.3% with thrombectomy, and 1.0% with both interventions. The authors did not report the severity of the stroke measured by NIHSS, the disposition of the patients (or discharge destination), or specifics of the institutional quality improvement projects. They suggested that responders to Code Stroke or RRT Stroke should also be trained in other neurological emergencies so they can distinguish mimics from strokes and can treat appropriately and timely IHSs.

Husseini and Goldstein (2013) compared characteristics and processes of stroke identifications between the in-hospital identification of stroke and stroke recognition in a single hospital ED. Activations for IHS occurred most often on cardiac units -236% and surgical department -38.7% with stroke mimics accounting for 63.4% of the calls. RRT code stroke was expected to respond within 15 min of notification, perform initial assessment and order laboratory and radiology studies if necessary. Severity of reported strokes in IHS and COS was similar – NIHSS=6. Thrombolysis was administered only in 2.7% in the first group vs. 25.9% in COS ($p < .004$). The frequency of discharge or disposition to home were similar in both groups 62.5% for ACVDs cases vs. 66.6% ($p = .07$). for patients entering through ED. The authors proposed that educating staff on

correct recognition of acute stroke symptoms and implementation of standardized code stroke protocols might improve the efficiency and quality of care for in-hospital onset strokes.

Another example of code stroke algorithm development and implementation in a single hospital was reported by Kassardjian et al. (2017) comparing data prior to and post-implementation on last seen normal (LSN) to initial assessment and LSN to brain imaging throughout 36 months. A total of 218 code strokes were reported, 87 of them post the implementation of their intervention. Most commonly identified features in the code stroke were unilateral weakness, speech disturbance, and facial droop. The cardiovascular service had the highest proportion of codes- 42%. After the introduction of the code median time to brain imaging fell from 600 min to 160 min, and specifically from an initial assessment to brain imaging from 135 to 110 min. The authors identified a lack of protocols as an impediment to the care of patients having stroke while hospitalized for another emergency and focused on EBP and dissemination of knowledge in engaging all stakeholders involved in care delivery. The study was performed before thrombectomy becoming a standard for care for stroke patients and therefore did not reflect the procedure as an option to IHS. Through studying workflows and developing checklists for ideal times, they were able to reduce the time to imaging by 57%. Their results suggested that in-hospital staff education regarding stroke urgency and a development of a code stroke algorithm could be key factors in improving the quality of care and the outcomes of patients with ACVDs.

Koge et al. (2017) developed educational workshops for early recognition of stroke symptoms and implemented a code stroke protocol for IHS. After implementation of their interventions the median time from stroke recognition to evaluation by neurologist was reduced from 30 minutes to 13.5 minutes ($p < .001$), the mean time from first imaging to thrombolysis from 45 min to 16 min ($p = .002$), and endovascular therapy times decreased from 75 minutes to 53 minutes ($p = .08$). The authors did report no differences in favorable outcomes between COS and IHS at discharge, or any complications of thrombolysis or thrombectomies in IHS, thus confirming that both are safe when timely and appropriately administered in the inpatient onset strokes. As they concluded, the implementation of a well-developed protocol for recognition and treatment in a CSC, together with a mobile stroke team can improve significantly the outcomes of patients who suffer stroke during their hospital stay.

Stecker, Micheal, Antaky, Wolin, and Koyfman (2015) investigated the stroke alerts in a general hospital and compared data on patients entering the hospital with a diagnosis of stroke versus hospital activation for in-patient onset of stroke. While very sensitive (95.6% properly activated), the calls had a very low specificity for the detection of true strokes – about 41%. Code stroke was activated most often on the medical-surgical units- at 34%. The NIHSS was 8.2 for IHS and NIHSS=6.3 for COS-NIHSS=6.3 with a $p < .001$, and the length of stay for COS was 6.3 vs. 11.6 for IHS with a $p <.001$. Overall quality metrics were lower for HIS, a finding consistent with other studies- last well known to stroke alert in ED 289 min vs. 395 min in the hospital units, stroke alert to assessment 9.2 min vs. 4.2 min in ED, stroke code to laboratory draws

completed 60min vs. 44.5 min in ED. The authors suggested focusing on accuracy of initial stroke assessment, as the NIHSS is not the single indicator for a diagnosis of stroke. Brining a specialist early in the process will add to the specificity of stroke detection. Additionally, constant review of the process and analysis of factors for delays will improve the care of IHS.

Yoo at al. (2016) presented results of a targeted stroke activation program developed for cardiology and cardiovascular surgical departments and early detection of stroke in this subpopulation of hospital patients with a total of $N = 70$ patients. After implementation of the program the following improvements in quality indicators were recognized: times from symptom onset to neurology notifications decreased from 50min to 28 min ($p = .33$), symptoms onset to imaging 91min vs. 41 min ($p < .001$), symptom onset to thrombolysis 120 min to 65 min ($p < .001$) and to intervention 295 min to 165 min ($p <. 001$). The authors attributed the improvements to the development of computerized order sets and staff training on the targeted units in early recognition and identification of patients developing stroke symptoms.

Analysis of the articles for the current review demonstrated delays in recognition, response team activation, and treatment of patients suffering from ACVD while hospitalized. While individual hospitals have attempted to improve work flow or implement specialized teams to respond to new onset of stroke in already hospitalized patients, no examples of published protocols have been replicated, tested, and reported as successful in the available literature. As the reports from individual hospital show,

improvements in the quality of these stroke patients is possible and they could have better outcomes when involved stakeholders and providers combine their efforts.

In 2018 the ASA/AHA published new guidelines for care of the acute stroke patients (Powers et al., 2018) with strong recommendations for application of tele-stroke/tele-neurology as an effective method of assessment for acute stroke and selection for thrombectomy. Both recommendations are Class IIb or useful but not well tested or established. Participation in a stroke depository (e.g., GWG) and extending the window for mechanical thrombectomy in selected patients beyond six and up to 24 hours of symptoms onset were classified as Class I recommendations for centers taking care of stroke patients (Powers et al., 2018). Although telemedicine has been around for a while with reported effectiveness (Rubin & Demaerschalk, 2014), I could not find any reports on its utilization by code stroke teams or in evaluation of IHS. Therefore, we must combine technology, expertise, and EBP (or current guidelines) in our current clinical practice, so we can reduce the mortality and morbidity of patients suffering stroke while hospitalized and deliver the same quality of care as in COS. In addition, we need to develop appropriate quality indicators for our inpatients strokes or agree to implement the same indicators that we use for patients entering the hospital through ED.

Findings Summary

Analysis of the selected articles in the current literature review revealed disparities in care between in-hospital and community onset strokes. Some of the studies focused on analysis of characteristics and outcomes of patients with ACVD, highlighting the gaps in their care. Few articles reported organizational interventions to improve

quality metrics and delivery of timely care to those patients. All studies emphasized the complex etiology of in-patient strokes and the need of specific stroke pathways in their care. Most interventions consisted of educational programs in early stroke recognition for medical and nursing staff and/or an implementation of specialized response team with stroke-specific knowledge. There is a lack of high-level evidence on the topic of in-hospital strokes. The complexity of the patients suffering stroke while hospitalized for another acute health event and hospital environment of competing and conflicting priorities require multifaceted intervention and multidisciplinary collaboration. As some of the studies demonstrated improvements in achieving high quality metrics are possible when program structures and processes are well aligned. More research is needed to establish the most effective approaches of care for in-hospital strokes.

Recommendations

Based on the review of literature recommendations for hospitals taking care of acute stroke patients include:

- Proper reporting of IHS into a selected depository, whether this is GWG or regional/state-wide registries. In 2018 DNV published new quality metrics for CSC (DNV, 2018) requesting that hospitals have developed protocols for IHS. This requirement needs to be extended to the primary centers, so we can analyze more complete data and identify opportunities for improvement at organizational and nationwide level.
- Education of staff regarding symptoms of stroke and early activation of hospital response system, so patients can be treated in a timely manner.

Utilization of the same tool for an assessment throughout different units should reduce the false activation calls. In addition, early involvement of neurology specialist should help identify stroke- staff members need to understand that a positive score on NIHSS does not necessary equate to a diagnosis of stroke. Expert stroke provider should be able to distinguish with a reasonable accuracy a stroke mimic from a new onset stroke. Telemedicine/tele-neurology should be utilized when a provider is not physically available for patient assessments.

- Hospitals should develop code stroke as a separate code from RRT. The composition of the stroke team should include neurologist or AP with stroke experience. They should design protocols specific to IHS with appropriate quality metrics and constantly review them.
- Collaboration with other departments and units where patients are at high risk for post-procedural ACVDs, such a surgical and cardiac unit, is paramount. When stroke patients are placed on a medical telemetry unit, I propose alternative placement on cardiac units or step-down units, where staffing strains and knowledge of cardiac disease can be combined in treating stroke patients' comorbidities and improving their outcomes.
- Hospitals should evaluate current internal processes and analyze them so that they can determine opportunities for QI projects. Once designed, a code stroke with an appropriate protocol (care pathway). Often quality initiatives stop at the first Pan Do Study Act cycle – a mistake that could costs abandoning great

projects early in the process and prior to seeing good results. Code stroke processes need to be evaluated continuously, so opportunities for shorter times and better outcomes of IHS can be identified and acted upon.

Strengths and Limitations of the Project

The strength of the current literature review was the contribution to the body of knowledge regarding the care of patients who suffer stroke while hospitalized for another emergency. Another strength was the inclusion of articles within the last ten years, during which technological and medical advances have allowed providers to advance the care of stroke patients. To my knowledge, this was the first systematic review of literature on the topic. In addition, in 2018 new guidelines by AHA/ASA (Powers et al., 2018) and structural and quality requirements for CSC by certifying bodies (DNV, 2018) direct their attention to this specific population. Provided with the results of the current review, clinicians, and stakeholders dedicated to the improvement of the outcomes in this patient population, can focus and develop appropriate interventions and apply EBP in their organizations.

The current review had limitations. There was a lack of studies combining results from multiple organizations – most of the reports on quality improvement strategies came from individual hospitals with a small sample size. The Level of evidence as graded by the Melnyk and Fineout-Overholt criteria for a hierarchy of evidence was IV and VI (Fineout-Overholt et al., 2010). Only one literature review (Level V evidence) - a narrative review was published and included six articles with a study period between 1997and 2017 (Chen et al., 2018). The articles selection was done by a single researcher

(the student), thus introducing the possibility of a selection bias. Studies in other languages or not available in full text were excluded, therefore potentially eliminating valid evidence with a good quality.

Summary

The SR offered background on characteristics and specific aspects of care for patients with SVCDs, as well as individual programs at organizational level to improve he care of this stroke population. Awareness of current guidelines, EBP, requirements for certification and maintain stroke center certification and experience in stroke care are critical components of quality initiatives to advance the care of IHS and eliminate the gaps between them and patients with COS. Educational, organizational, and workflow barriers should be removed to achieve a reduction in their mortality and morbidities. Through collaborative interdisciplinary efforts in current economic environment of VBM, health care providers can achieve this if they engage everyone involved in the care of those patients.

Section 5: Dissemination Plan

Introduction

IHSs have complex etiology and need a multi- and interdisciplinary approach for an early detection, a proper diagnosis, and a timely treatment with an appropriate therapy modality according to current acute stroke care guidelines (Bhalla et al., 2010; Cumbler et al., 2011; Cumbler et al., 2014; Saltman et al., 2015; Stecker et al., 2015; Yoo et al., 2016). In this SR, I focused on available reports regarding improving quality and delivery of care to patients suffering from a stroke while hospitalized for another emergency or exacerbation of another condition. This final section contains the dissemination plan and a self-analysis.

Dissemination Plan

The dissemination of the results of this SR will highlight the current gaps in care for hospitalized patients with new onset ACVD as well as underscore the need to change current practices and apply evidence-based clinical approaches to their treatment. Different avenues for drawing clinicians' attention to the current issues in the care of this subpopulation of stroke patients are publications, presentations, and group discussions at multiple organizational levels. Translating the gained knowledge into a publication will be one of my goals after the completion of the DNP program. After a revision, I will select appropriate journals, with a focus on stroke care, for submission, including the *Journal of Neuroscience Nursing*; *Stroke*; and *Interventional Neurology*, a journal with a section dedicated to neurovascular disease. The Oregon Stroke Network, an organization involved in disseminating results of research and best practices, is one of stakeholders

focused on improving stroke outcomes regionally. My plan is to submit an abstract to the Oregon Stroke Network's annual meeting and the conference on neurovascular diseases held by the Society of Vascular and Interventional Neurology in 2019. The recommendations drawn from the current evidence have been discussed in our stroke core team meeting at the study site as well as at the system level.

Analysis of Self

Conducting the SR required multiple skills, including a good understanding of the topic of the research, an awareness of the SR process itself, an ability to analyze published data, and the knowledge of the requirements for conducting a high-quality literature review. Learning how to conduct a SR was a daunting and important lesson, adding a skill set that will continue to be valuable in my practice. According to AACN (2006), an integration of knowledge from bioethical, biophysical, analytical, and organizational science represents the highest level of nursing practice. By conducting the SR and through my practicum, I achieved an integrated practice experience focused on a population I serve as a clinician. Applying the knowledge gained from the research project will help me achieve an improved interprofessional collaboration with other professionals involved in the care of this population and elevate my role as a stroke patient's advocate in institutional decisions regarding the designing and changing of policies. The completion of this project enhanced my skills in communication, analysis, and synthesis of current best practice evidence, thus planning and improving current workflow processes and applying clinical guidelines in complex organizations, such as hospitals, will become an integrated part of my future interventions and practice.

Summary

In this final section of the project, I concluded the SR on the topic of IHSs. My plan for dissemination and the skills gained from my engagement in the scholarship of nursing practice were assessed. In addition, I outlined the need for changing the professional approach to the care of this subpopulation of stroke survivors. The results of the SR can serve as a guide for clinicians in adopting new practice approaches to in-patient stroke care in the environment of complex organizations such as hospitals.

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Appendix A: Summary of Articles Included in the Systematic Review

Authors/Year	Level of evidence	Study design	Setting	Sample size *N*	Outcomes
Bhalla, A., Smeeton, N., Rudd, A. G., Heuschmann, P., & Wolfe, C. D. (2010).	IV	Retrospective cohort	City-wide registry	*N* = 291	Rate of IHS -11%, length of stay for IHS 55.9 days vs. 37.9 for COS. Recommendation for hospital policies and guidelines specific to IHS
Bunch, M. E., Nunziato, E. C., & Labovitz, D. L. (2012).	VI	Chart Review	Single hospital	*N* = 79	The incidence of IHS was 16% with 18% of cases identified with delays, NIHSS=13 vs. NIHSS=5 in COS, 56% of IHS had a surgery prior to their event, and additional 37% could have received thrombolysis if detected on time. Recommendation for staff education regarding signs and symptoms of stroke.
Campello, A. R., Godia, E. C., Steinhauer, E. G., Fernandez, E. R., Dominguez, A., Romeral, G., ... Roquer, J. (2015).	VI	Descriptive	Single hospital	*N* = 60	Development of educational program for staff education of early recognition of stroke symptoms. Overall 68.3% were assessed in less than four and a half hours of symptoms onset, and 10% underwent endovascular therapy.
Caparros, F., Ferrigno, M., Decourcelle, A., Hochart, A., Moulin, S., Dequatre, N., ... Leys, D.(2017, July 15)	IV	Retrospective cohort	Single medical center	*N* = 1,209	Rate of 5.5% IHS, 17 min faster treatment in HIS vs. COS, 30days mRS of zero to three in 73% of IHS, no significant differences at baseline between the two groups. Great outcomes should be pursued and achieved through focusing on at risk departments (cardiac and surgical), clinical pathways, and organized in-hospital stroke care.

Chen, S., Singh, R., Kamal, N., & Hill, M. D. (2018).	V	Narrative literature review	Six studies	*N* = 38,965	IHS had lower rates of treatment 9.1% vs. 16.8% with thrombolysis at 12% vs. 19% for COS. IHS were less likely to be discharged home- 49.9% vs. 27.7% of COS. Mean stay was IHS was 21 vs. 13 days was COS. Delays in stroke recognition, stroke treatment activations, imaging and diagnosis, and treatment times were noted in all studies. Authors recommended establishing protocols, widespread educational programs in stroke recognition, and utilizing evidence-based practices for responding to in-hospital strokes.
Cumbler, E. (2015)	IV	Retrospective Cohort	Colorado and Michigan state-wide stroke registry s	*N* not reported	Analysis of QI – IHS time of onset to imaging of 98 min vs. 29 for COS, thrombolysis 31.6% vs. 73.4%, overall defect-free care 60.8% vs. 82.0%. Hospitals should focus on improving recognition of strokes, decreasing the delays between onset and evaluation. Currently, there is poor adherence to quality indicators and poor transitions of care for IHSs.
Cumbler, E., Anderson, T., Neumann, R., Jones, W. J., & Brega, K. (2010)	VI	Descriptive	Single center	*N* = 10 pre intervention *N* = 44 post intervention	Development of new protocol and utilization of acute stroke team to identify IHS and improve treatment. Symptom recognition to CT decrease from 271 to 74 min (p = .02), despite the intervention response times for IHS were 98 min vs. 29 min for COS in ED. Authors concluded that when properly activated by trained staff RRT Stroke can improve quality metrics and outcomes of IHS.

Cumbler, E., Murphy, P., Jones, W. J., Wald, H. L., Kutner, J. S., & Smith, D. B. (2011).	IV	Retrospective cohort	Colorado state-wide registry	*N* = 116	IHSs were more sever with a mean NIHSS = 9.5 vs NIHSS = 7.0 (p = .01) in COSs, time to brain imaging was 54 vs. 43 min (p = .13) and deficit-free care was 52.8% in IHS vs. 32.2% in COS patients (p < .0001). Adherence to performance measures was better for IHS. However, their evaluation took twice as long as the recommended benchmark of 25min, thus representing an opportunity for a process improvement
Cumbler, E., & Simpson, J. (2015).	VI	Dsecrip tive	Six hospitals	*N* = 393	A team- based quality improvement program with an implementation of RRT or specialized code stroke teams. Average rate of 46.1% stroke mimics, variable criteria for calling code stroke, no interrater reliability of stroke assessments. No ability to assess false negative calls.8.2% of ISH were treated with thrombolysis and 10.3 only with thrombectomy. RRT or code stroke teams need to be trained to recognize and respond to condition beyond ischemic stroke presentation.
Cumbler, E., Wald, H., Bhatt, D., Cox, M., Xian, Y., Reeves, M., & Fonarrow, G. (2014).	IV	Retrospective cohort	GWG nationwid e registry	*N* = 21,349	IHS had higher median NIHSS (9.0 vs. 4.0, p < .001), lower defect free care (60.8% vs. 82.0%, p < .001),and were less likely to be able to ambulate independently on discharge (*OR* = 0.37, *CI* = 95%). The authors recommended developing stroke specific protocols, reporting IHS, and improving hospital processes.

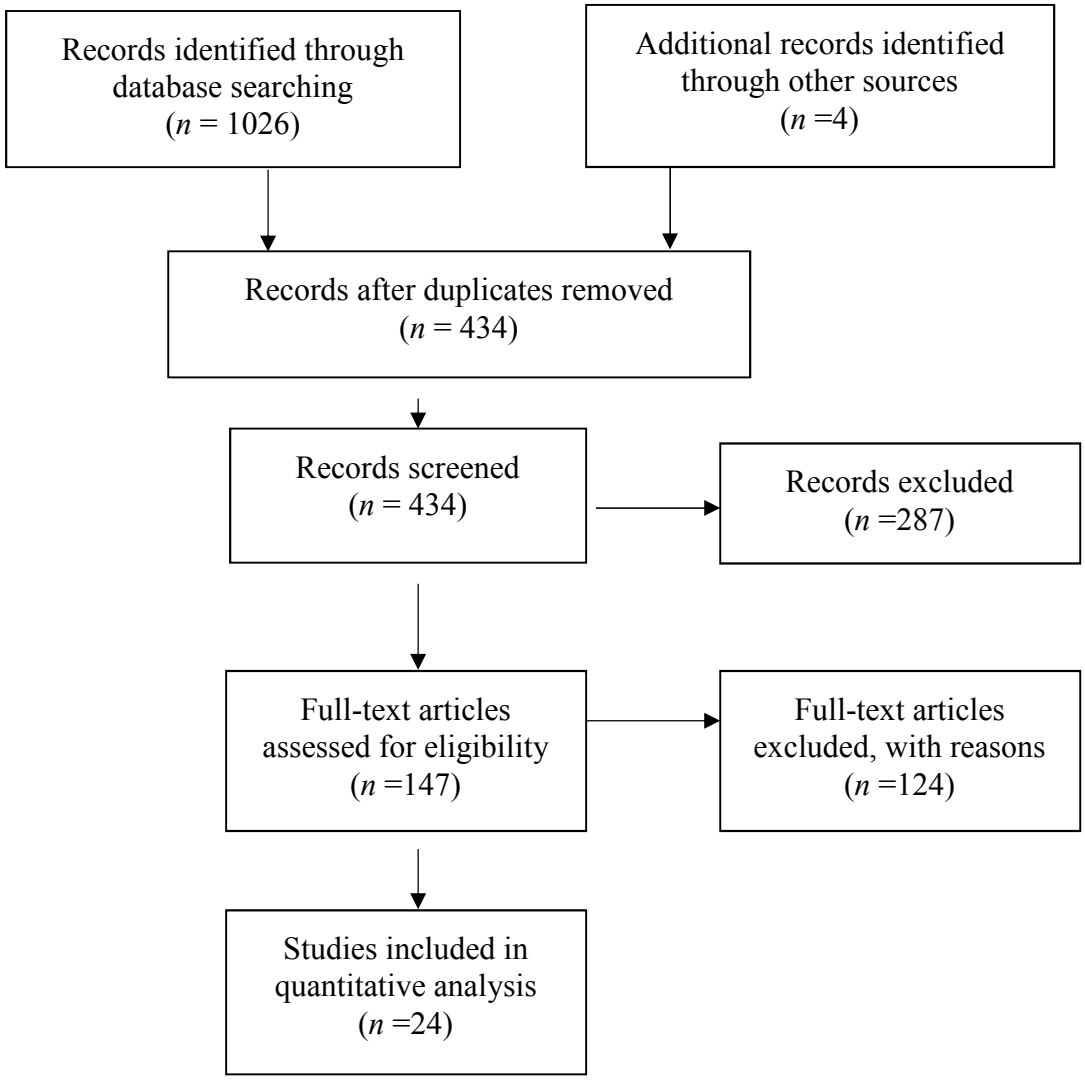
Emiru, T., Adil, M. M., Suri, M. K., & Qureshi, A. I. (2014).	IV	Cohort study	National Registry	*N* = 25,193	Mean hospital stay eight days in IHS vs. 7 in COS ($p < .001$), higher mortality OR-=1.17 with CI=95%, thrombectomy utilization of 8.1% in IHS vs. 5.6% in COS, delays in door-to-imaging mean of 39.5 vs. 19.7 min, and imaging to treatment 92.0 vs. 65.4 min, $p < .001$). Hospitals should develop in-patient code stroke teams in order to bring specialist faster to the patients and improve their outcomes.
Farooq, M. U., Reeves, M. J., Gargano, J., Wehner, S., Hickenbottom, S., & Majid, A. (2008)	IV	Cohort Study	National In-patient Registry	*N* = 25,193	Endovascular treatments in IHS were 9.6% vs. 6.1% in COS, length of stay eight vs. seven days, delays in care door-to-CT 39.5min vs. 19,7 min and CT-to-treatment 92.0 vs. 65.4 min, $p < .001$). Cost of stay was $74,713 vs $68,429 for COS. Recommendations for better reporting of IHS and developing of specific systems of care for them.
Husseini, N. E., & Goldstein, L. B. (2013).	VI	Descriptive	Single hospital	*N* = 93	Code stroke was activated most often on cardiac 23.6% and surgical units-38.7%. Stroke mimics accounted for 63.4% of in-hospital code strokes. IHS received less thrombolytics 2.7% vs 25.9% in COS ($p < .004$). Accurate recognition of stroke is key in treatment of IHS. Recommendations for standardized protocols for recognition and treatment of IHS.
Kassrdjian, C. D., Willems, J. D., Skrabka, K., Nisenbaum, R., Barnaby, J., Kostyrko, P., ... Saposnik, G. (2017).	VI	Descriptive	Single hospital	*N* = 218	Reduction of median time to brain imaging from 600 min to 160 minutes, and from initial assessment to brain imaging from 135 to 110 minutes after implementation of code stroke. Developing algorithms and staff education on stroke symptoms proposed.

Koge, J., Matsumoto, S., Nakahara, I., Ishii, A., Hatano, T., Sadamasa, N., ... Nagata, I.(2017)	VI	Descriptive	Single hospital	*N* = 97	An educational intervention and implementation of IHS protocol. Reduction of time from recognition to neurology assessment from 30 min to13.5 min ($p < .001$) and mean time from first imaging to thrombolysis from 45 min to 16 min ($p = .02$), endovascular therapy times decrease from 75 min to 53 min ($p = .08$). Conclusions- a well- developed protocol, a mobile stroke team (RRT stroke), and staff education can improve quality of care for IHS.
Manawadu, D., Choyi, J., & Kalra, L. (2014, August 21).	IV	Prospec tive cohort	Single hospital registry	*N* = 1,836	IHS rate of 4.6%, 80% recognition of stroke within three hours of onset of symptoms, no differences in mortality between IHS and COS. About 19% would have received thrombolysis if symptoms recognized within the therapeutic window. Recommendations for faster recognition, imaging, and therapy in IHS.
Moradiya, Y., & Levine, S. R. (2013).	IV	Retrospective cohort	National inpatient sample	*N* = 1,020	Rate for IHS was 8.7%, mortality of 15.7%, discharge to home -22.8% vs. 30.0% in COS, intracranial bleeds 4.7% vs. 5.3% in COS. Thrombolysis is safe and feasible in IHS if patients are assessed within the therapeutic window.
Natteru, P., Mohebbi, M. R., George, P., Wisco, D., Gebel, J., & Newey, C. R. (2016).	IV	Retrospective cohort	Single center	*N* = 93	Stroke onset to neuro evaluation for HIS was 24.8 min, onset-to-treatment 236.6 min, onset to CT scan 67min, evaluation to needle 213.8 minutes. Median NIHSS = 10. Knowledge or patients risk factors and fast evaluation will improve treatment times and outcomes of the patients.

Park, H. J., Cho, H. J., Kim, Y. D., Lee, D. W., Choi, H. Y., Kim, S. M., & Heo, J. H. (2009)	IV	Retrospective cohort	Single center	$N = 111$	IHSs had 10-fold higher mortality than COSs, higher neurological deficits (19% vs. 2%, $p < .001$) mean length of stay was 30.1 vs. 11.0 ($p < .001$), only 2.7% of IHS received thrombolysis. Recommendation for targeted education, mobile stroke team, and focus on units with high risk population.
Saltman, A. P., Silver, F. L., Fang, J., Stamplecoski, M., & Kapral, M. K. (2015).	IV	Retrospective cohort	Multiple centers in Canadian Province	$N = 973$	Longer times from recognition to neuroimaging 4.5 hrs. vs. 1.2 hr. ($p < .001$), lower rate of thrombolysis 12% vs. 19 %, $p < .001$), greater stroke severity and higher probability of less favorable outcomes (MRS of three to six) $OR = 1.64$ with $CI =$ 95%. Recommendations for a standardized approach to early recognition and management of IHS, specific pathways, and use of mobile stroke teams.
Schuermann, K., Nikoubashman, O., Falkenburger, B., Tauber, S. C., Wiesmann, M., Schulz, J. B., & Reich, A. (2016)	IV	Retrospective cohort	Single center	$N = 331$	IHS rate was 9.4%, mortality 31.4% vs 8.0% in COS, length of stay 19.5 vs 12.1 days, 15.7% received reperfusion therapy. Symptoms to imaging median of 73.3 vs. 30.9 min, symptoms to thrombolysis 84.9 min vs. 37.9 min, symptoms to angiography 124.2 vs. 91.8 min ($p < .001$). Mean NIHSS=14.9 in HIS vs. 11.9 in COS. Delays of treatment were attributed to late symptom recognitions and transportation to imaging. Recommendations included education of medical staff regarding stroke and standardization of in-hospital processes, as well as focus on specific units (cardiac and cardiosurgical).

Stecker, M. M., Michael, K., Antaky, K., Wolin, A., & Koyfman, K. (2015).	VI	Descriptive	Single hospital	*N* = 983	Low probability of stroke with a high sensitivity alerts (only 41% of alerts were true strokes). Medical units -highest stroke alert at 34%. Higher acuity of IHS NIHSS = 8.2 and COS-NIHSS = 6.3 ($p < .001$), median length of stay for COS was 6.3 vs. 11.6 for IHS ($p < .001$). Overall quality metrics lower for IHS. Recommended specialty (neurology) involvement early as NIHSS alone does not confirm diagnosis of stroke
Vera, R., Lago, A., Fentes, B., Gallego, J., Tejada, J., Casado, I., ... Masjuan, J. (2011).	IV	Retrospective cohort	Multi center	*N* = 273	52% of IHS were evaluated by neurology within three hours of symptoms onset, 15.7% received thrombolytic therapy, 14.7% did not due to delays in diagnosis, and mortality was 18.4% ($p < .001$) in this population. The authors suggested educational programs in early recognition of stroke and improving hospital pathways for care of those patients.
Yoo, J., Song, D., Baek, J., Lee, K., Jung, Y., Cho, H., ... Heo, J. H. (2016).	VI	Descriptive	Single hospital	*N* = 70	After implementation of stroke code program on cardiac and cardiovascular surgery departments times from symptom onset to neurology notifications decreased from 50min to 28 minutes ($p = .33$), symptoms onset to imaging 91minuntes vs. 41 minutes ($p < .001$), symptom onset to thrombolysis 120 minutes to 65 minutes ($p < .001$) and to intervention 295 minutes to 165 minutes ($p < .001$). Computerized order sets and staff education were identified as factors for improved quality of care in IHS.

Appendix B: Literature Review Flow Chart



Adapted from "The PRISMA statement for reporting systematic reviews and metanalyses of studies that evaluate health care interventions: Explanation and elaboration", Liberati et al., 2009, *PLoS Medicine*, *6*(7). Available from http://prisma-statement.org/