Identifying Obstructive Sleep Apnea Risk in Stroke Patients by Utilizing the STOP-Bang Questionnaire

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Table of Contents

Abstract

Obstructive sleep apnea is a modifiable stroke risk factor that is often overlooked when addressing stroke risk factor management. By screening stroke patients for obstructive sleep apnea risk and treating it once diagnosed, improvement is achieved in stroke risk factor management. The purpose of this quasi-experimental, one cohort, pre- and post-test, evidence-based quality improvement project was to improve stroke risk factor management by screening and treating stroke patients for obstructive sleep apnea. Sixty-seven radiographically confirmed stroke patients were recruited by convenience sampling from a local hospital. The STOP-Bang questionnaire was utilized to screen for obstructive sleep apnea risk. Those identified at risk were provided an opportunity to schedule a polysomnography and office visit to address obstructive sleep apnea management. Identifying obstructive sleep apnea risk and improved stroke risk factor management were measured in this project. Almost sixty-nine percent of the stroke patients screened were identified as at risk for obstructive sleep apnea. Only one participant completed polysomnography, and this participant adhered to recommended treatment and demonstrated improved stroke risk factor management. Untreated obstructive sleep apnea in stroke patients has a significant impact on patients, their families, and the healthcare system. Untreated obstructive sleep apnea in stroke patients can hinder stroke recovery, potentially leading to long-term disability and increasing the burden on the healthcare system.

Keywords: obstructive sleep apnea, stroke, STOP-Bang questionnaire, stroke risk factor management

Identifying Obstructive Sleep Apnea Risk in Stroke Patients by Utilizing the STOP-Bang Questionnaire

Stroke is the fifth leading cause of death of men in the United States with roughly a four percent mortality rate and the fourth leading cause of death of women in the United States with roughly a six percent mortality rate (Heron, 2019). Addressing modifiable stroke risk factors is key in reducing the number of initial and recurrent strokes. The American Stroke Association (2020) lists hypertension, atrial fibrillation, diabetes, hyperlipidemia, and smoking cessation as a few modifiable stroke risk factors. A modifiable stroke risk factor often overlooked is screening patients for obstructive sleep apnea (OSA) risk. It is estimated that 80% of the 22 million Americans with sleep apnea are undiagnosed (American Sleep Apnea Association, 2020). The prevalence of undiagnosed OSA is significantly high in stroke patients, and stroke patients with undiagnosed OSA tend to experience a higher mortality rate and worse functional outcomes (Benjamin et al., 2019; Garvey et al., 2015). Many providers, including those in the stroke medical community, are not screening their stroke patients for OSA risk (Navalkele et al., 2016). This often missed opportunity is ideal for implementing an OSA screening intervention to improve stroke risk factor management.

Significance

Many studies have shown not only a correlation between OSA and stroke but the importance of identifying and treating this modifiable stroke risk factor (Amra et al., 2018; Boulos et al., 2016, 2019; Davis et al., 2013; Katzan et al., 2016; Mohammad et al., 2018; Rao et al., 2016; Severine et al., 2016; Skolarus et al., 2012; Zhang et al., 2019). Data results indicate that the most common form of sleep disordered breathing or sleep apnea is OSA (Davis et al., 2013). Current guidelines for stroke prevention recommend a provider consider OSA evaluation in stroke patients, leaving OSA screening to the discretion of the provider (Kernan et al., 2014). With minimal emphasis on OSA screening within the guidelines, the provider could feel OSA is not a vital stroke risk factor.

Several studies estimated the prevalence of sleep apnea in stroke patients is around 50 to 70% (Dong et al., 2018; Losurdo et al., 2018; Katzan et al., 2016; Menon et al., 2017) with an upward of almost 90% in one study (Huhtakangas et al., 2018). Obstructive sleep apnea may predate the stroke, worsen initially after the stroke, and persist over time (Benjamin et al., 2019; Davis et al., 2013). Fully treated OSA has been shown to improve cognitive and neurological symptoms and functional status in stroke patients (Bravata et al., 2018; Menon et al., 2017; Ren et al., 2019; Zhang et al., 2017).

The impact of OSA and stroke is significant on patients, families, and the healthcare system. Between 2001 and 2005, outpatient stroke rehabilitation services and medications cost an average of $11,145 for the first-year post-hospital discharge (Benjamin et al., 2019). From 2014 to 2015, cardiovascular disease and stroke accounted for 14% of the total United States health expenditures, which was more than any major diagnostic group (Benjamin et al., 2019). From 2015 to 2035, the total direct medical stroke-related costs are projected to significantly increase from $36.7 billion to $94.3 billion (Benjamin et al., 2019). The impact of undiagnosed OSA is even more significant on healthcare costs. In 2015 the estimated cost for undiagnosed OSA in the United States was $149.6 billion and only continues to rise (Frost & Sullivan, 2016).

Stroke patients have an increased risk of post stroke depression, and approximately one-third develop depression within the first-year (Towfighi et al., 2017). Stroke has a high occurrence of long-term disability (Benjamin et al., 2019), which could affect post stroke depression. Additionally, depressive symptoms are often missed by providers, and post stroke depression goes undiagnosed (Towfighi et al., 2017). In older adults, post stroke depression is thought to be the most common neuropsychiatric consequence of stroke (Lokk & Delbari, 2010). Individuals with post stroke depression have a significant risk for poor stroke recovery, poor quality of life, recurrent strokes, and even death (Towfighi et al., 2017).

The significant mortality rate data for both stroke and OSA stress the importance of evaluating and treating both chronic diseases. Data collected from the Atherosclerosis Risk in Communities (ARIC) study from 1987 to 2011 showed the cumulative mortality rate after stroke was 10.5% within the first thirty days, 21.2% at one year, 39.8% at five years, and 58.4% at the end of the 24-year follow-up (Koton et al., 2014). Mortality, specific to OSA, has somewhat limited data, but a study by Young et al. (2008) monitored OSA mortality data over eighteen years. Approximately 42% of deaths in individuals with severe OSA attributed to cardiovascular disease or stroke, while only 26% of deaths were noted in individuals with no OSA (Young et al., 2008).

Another impact of stroke and OSA on patients and the healthcare system is hospital readmissions and stroke recurrence. Thirty-three percent of ischemic stroke patients have unplanned readmissions within 30 days of their initial event secondary to recurrent strokes (Rao et al., 2016). A systematic review and meta-analysis by Mohan et al. (2011) reported the cumulative stroke risk reoccurrence was 3.1% within 30 days of the initial event, 11.1% at one year, 26.4% at five years, and 39.2% at ten years. Another systematic review and meta-analysis reported the annual risk of recurrent stroke in stroke or transient ischemic attack (TIA) patients was 4.26% (Boulanger et al., 2018).

Local Issue

In 2019, according to the America's Health Rankings (2020) annual report, the state of Missouri ranked 41 out of 50 regarding the percentage of adults being told by a healthcare provider that they had a stroke. This significant finding indicates that only nine other states had a higher stroke incidence than Missouri. From 2015 to 2017, the Center for Disease Control and Prevention (2017) reported stroke death rates for the state of Missouri were 71.8 to 79.7 per 100,000 for individuals age 35 to 65 years. From 2015 to 2017 for individuals greater than age 65, the stroke death rate was significantly higher at 251.4 to 275.5 per 100,000 (Center for Disease Control and Prevention [CDC], 2017). These staggering stroke statistics laid the foundation for the project.

In the 2014 updated stroke prevention guidelines, it was recommended to consider screening stroke and TIA patients for OSA (Kernan et al., 2014). Routinely screening stroke patient's for OSA risk was not standard practice at the project site. This 285-bed hospital is a primary stroke center with over 1100 stroke evaluations annually. By implementing OSA screening and treatment to stroke patients within this setting, the local issue of stroke incidence was addressed.

Diversity Considerations

The project setting was within Jackson County, Missouri. According to the United States Census Bureau (2010), there are over 670,000 residents within this county. Within Jackson County, approximately 51.7% are female, 48.3% are male, 70.3% are Caucasian, and 24.0% African American (United States Census Bureau, 2010). For Missouri, the stroke rate for females in 2019 was 4.4%, and only 3.9% for males (America's Health Rankings, 2020). According to America's Health Rankings (2020) annual report in 2019, African Americans had 6.5% stroke incidence, compared to only 3.8% for Caucasians.

Problem and Purpose

In the United States, every forty seconds, an individual has a stroke (Benjamin et al., 2019). It is estimated that over seven million Americans, greater than 20 years of age, have a history of stroke (Benjamin et al., 2019). By 2030, an additional 3.4 million Americans will suffer from a stroke, a 20% increase in prevalence from 2012 (Benjamin et al., 2019). Additionally, the number one leading cause of serious long-term disability in the United States is stroke (Benjamin et al., 2019). Individuals with untreated moderate to severe OSA almost double their risk for stroke (Xie et al., 2017). Focusing on stroke risk factor management is an efficient method to decrease stroke risk or recurrent stroke. Ensuring all aspects of modifiable stroke risk factors are addressed, including identifying OSA risk and providing treatment, is imperative to improve stroke risk factor management and decrease potential stroke or recurrent stroke events.

Problem Statement

Uncontrolled stroke risk factors, including undiagnosed and untreated OSA, increases individuals’ risk for stroke, affecting their quality of life and overall health.

Intended Improvement with Purpose Statement

Obstructive sleep apnea prevalence in stroke patients is greater than 50% (Huhtakangas et al., 2018; Losurdo et al., 2018; Menon et al., 2017). The prevalence of sleep-disordered breathing issues after stroke is high and persists over time (Seiler et al., 2019). By focusing on improving stroke risk factors, there is potential to reduce recurrent stroke events. The purpose of this project was to identify OSA risk and determine if the evidence-based OSA screening intervention and then referral for OSA treatment improved stroke risk factor management at a local hospital.

Facilitators, Barriers, and Sustainability

The neurology team was the main facilitator for the project, which consisted of four physicians, three nurse practitioners, and two stroke coordinators. The economic component of the project was also a facilitator. Stroke patients were already evaluated for management of stroke risk factors. Adding OSA screening does not significantly increase the cost to the established stroke risk factor management process.

The main barrier to the project was patients not following through with recommended OSA testing once screened at risk for OSA. The project leader attempted to overcome this barrier by providing additional education and placed follow-up phone calls to those patients who were not initially willing to follow through with treatment recommendations. The time constraint of the project was another barrier. Some participants were willing to complete polysomnography (PSG), but they were unable to complete testing before the end of the data collection period.

There were no major issues with sustainability during the project. The local hospital has approximately 1100 stroke evaluations every year. This provided ample access to stroke patients to sustain the intervention.

Review of the Evidence

Inquiry

In stroke patients, does utilizing the STOP-Bang questionnaire and providing a referral for OSA management, if needed, identify OSA risk and improve stroke risk factor management over six months at a local hospital?

Literature Search Strategies

A comprehensive literature search relevant to the importance of screening for OSA in stroke patients was conducted utilizing various databases. The databases included Cochran, CINHL, PubMed, Medline through Ovid, ProQuest, and the Nursing and Allied Health

Database. The major keywords were obstructive sleep apnea, stroke, STOP-Bang questionnaire, and stroke risk factor management (see Appendix A, Definition of Terms).

Studies from 2010 to the present were included in the synthesis of evidence search. Although a few articles were outside the date range, they were included as gray literature because of the substantial evidence that added strength to the foundation of the inquiry. The primary inclusion criteria included articles on OSA in stroke patients and stroke risk factor management. For completeness to capture all aspects of the inquiry, additional themes were included in the literature search. Articles about the connection between OSA and stroke, OSA and stroke education, OSA prevalence, OSA effects on stroke recovery, and OSA management and treatment were included in the literature search. The primary exclusion criteria excluded articles that did not mention OSA along with stroke.

The initial literature search via the utilized databases yielded 101 articles. Once duplicates were removed, 63 remained. The remaining 63 articles were initially screened for relatability to the inquiry, and several were excluded, bringing the remaining total to 49 articles. Those articles were closely screened, and several were eliminated that did not closely align with the inquiry or did not add substantial evidence, leaving the 32 articles included within the synthesis of evidence (see Appendix B, PRISMA Diagram).

The 32 studies revealed a variety of study designs: two evidence-based practice guidelines, five systematic reviews or meta-analysis, twelve cohort studies, one case control study, two descriptive studies, eight random controlled trials, one cross sectional study, and one expert opinion article (see Appendix C, Synthesis of Evidence Table). Each study was then reviewed, and the level of evidence was identified utilizing Melnyk and Fineout-Overholt’s (2015) rating system for the hierarchy of evidence for an interventional inquiry. The review revealed seven level I studies, six level II studies, three level III studies, eleven level IV studies, one level V study, three level VI studies, and one level VII study.

Evidence by Themes

In reviewing the literature, six themes were identified as related to the inquiry: OSA screening, OSA and stroke risk factor management, stroke and OSA education, OSA and stroke recovery, stroke and OSA prevalence, and OSA compliance and management. Within each theme, a corresponding evidence theme surfaced and was explored. Identification of each evidence theme within the literature further solidified the need for the intervention (see Appendix D, Evidence Grid).

OSA Screening and Diagnosis in Stroke Patients

The gold standard for OSA diagnosis is through PSG (Kapur et al., 2017), but this is not easily done within an acute care setting, and insurance usually requires documentation showing a need for further evaluation before PSG is approved. Therefore, several screening tools have been developed and validated throughout the years to help quickly identify patients at risk for OSA. By utilizing these screening tools, the provider can easily identify patients at risk for OSA and then refer them on for PSG to obtain a formal diagnosis of OSA.

Unfortunately, both stroke medicine and general medicine, many providers do not routinely screen stroke patients for OSA, even though several simple screening tools are readily available (Navalkele et al., 2016). Three main questionnaires were identified in the literature: The Berlin questionnaire, the four-variable questionnaire, and the STOP-Bang questionnaire. Both the four-variable questionnaire and STOP-Bang questionnaire have a few variations. These questionnaires have been utilized for all patient types, including stroke patients.

The Berlin questionnaire was developed and validated in the late 1990s and contains questions about snoring, daytime somnolence, hypertension, and body mass index (BMI; Sadovsky, 2000). Through the literature review, only two studies were identified within the database search timeline that utilized the Berlin questionnaire for OSA screening in stroke patients (Mohammad et al., 2018; Skolarus et al., 2012). One study discovered that 72.5% of the study participants were at risk for OSA (Mohammad et al., 2018). The other research noted only 48% of the study participants were at risk for OSA (Skolarus et al., 2012).

The four-variable questionnaire utilizes gender, BMI, blood pressure, and snoring to identify patients at risk for OSA (Takegami et al., 2009). Takegami et al. (2009) developed and validated this tool by comparing results of sleep studies against the four-variable questionnaire and found that those patients who fit the four-variable questionnaire criteria showed moderate to severe sleep-disordered breathing, confirmed by PSG (Takegami et al., 2009). Zhang et al. (2019) modified the four-variable questionnaire by removing BMI and adding neck circumference to fit their study population better. Ultimately, they found similar predictability of OSA in stroke patients between the four-variable and modified four-variable questionnaires (Zhang et al., 2019). While this screening tool exhibits validity, it was noted to have minimal use within the specified database search timeline when focusing on OSA screening in stroke patients.

In pursuit of developing a reliable and easy to use screening tool, Chung et al. (2008) developed the STOP questionnaire and STOP-Bang questionnaire. Chung et al. (2008) validated the STOP questionnaire from their pilot study but were able to increase sensitivity and specificity by adding Bang to the questionnaire. The STOP-Bang questionnaire consists of eight yes or no questions related to the clinical features of sleep apnea, with a total score that ranges from zero to eight. This acronym stands for snoring (S), tired (T), observed pauses in breathing (O), elevated blood pressure (P), BMI greater than 35 (B), age older than 50 (A), neck size greater than 40 centimeters (N), and male gender (G). Answering yes to three or more items is high risk, and less than three items is low risk (Chung et al., 2008).

Some studies modified the STOP-Bang questionnaire in an attempt to improve validity and sensitivity. Boluos et al. (2019) added nocturnal oxygen desaturation and removed neck circumference (STOP-Bag-O), which showed statistical significance compared to the STOP-Bang questionnaire alone, but monitoring nocturnal oxygen desaturation is not always feasible. An additional study by Katzan et al. (2016) also removed neck circumference (STOP-Bag) and noted no statistically significant difference between the STOP-Bag or STOP-Bang questionnaires. Multiple studies have utilized the STOP-Bang questionnaire or variations of the questionnaire to screen stroke patients for OSA risk, all showing an increased risk for OSA based on the administered questionnaire (Amra et al., 2018; Boulos et al., 2016, 2019; Katzan et al., 2016; Severine et al., 2016).

For this project, the STOP-Bang questionnaire was utilized. The decision to utilize this questionnaire was based on frequent use within recent studies focusing on OSA diagnosis in stroke patients and that the tool has shown strength of validity, reliability, and sensitivity when screening stroke patients for OSA risk (Amra et al., 2018; Boulos et al., 2016, 2019; Katzan et al., 2016; Severine et al., 2016).

Treatment of OSA Improves Stroke Risk Factor Management

Once a patient is diagnosed with a stroke, the ultimate goal is to improve their stroke risk factors which decrease their risk for recurrent strokes. Many clinicians and researchers agree that OSA is a major risk factor for stroke and that all stroke patients should be screened for OSA risk (Jehan et al., 2018; Kernan et al., 2014; Kim et al., 2016; King & Cuellar, 2016). Stroke patients with treated OSA have shown statistically significant better stroke outcomes and a decrease in recurrence of vascular events (Gupta et al., 2018; Kernan et al., 2014; Kim et al., 2016; King & Cuellar, 2016; Schipper et al., 2017). Stroke patients with treated OSA have shown an improvement in cognitive function, overall function, and less time in rehabilitation than those with untreated OSA (Jehan et al., 2018).

OSA and Stroke Education Improves Patient Knowledge

Providing patients with the necessary education to make informed decisions about their health is imperative to improving their overall health. Individualized educational interventions on OSA and stroke education have been shown to improve adherence to stroke risk factor modifications (Dharmakulaseelan et al., 2019; Donald et al., 2018; Holzemer et al., 2011). Also, once provided education about stroke and OSA management, patients are more likely t0 understand the disease process better and seek guidance from their provider for OSA management (Donald et al., 2018).

OSA Treatment Improves Stroke Recovery

Stroke recovery can be cumbersome, exhausting, and physically and cognitively taxing for patients. Untreated OSA is thought to cause hypoxemia and sleep discontinuity in stroke patients, contributing to poor cognitive function that can be improved with OSA treatment (Ren et al., 2019; Zhang et al., 2017). By ensuring that OSA is treated, they can have statistically significant improvements in neurological symptoms and functional status (Bravata et al., 2018; Menon et al., 2017; Ren et al., 2019; Zhang et al., 2017).

OSA Prevalence is High in Stroke Patients

The prevalence of OSA is high in stroke patients, thus solidifying the need to screen stroke patients for OSA risk (Dong et al., 2018; Huhtakangas et al., 2018; Losurdo et al., 2018;

Menon et al., 2017; Seiler et al., 2019). Several studies noted the prevalence of OSA to be greater than 50% in stroke patients, reaching 90% (Huhtakangas et al., 2018; Losurdo et al., 2018; Menon et al., 2017). The prevalence of sleep-disordered breathing issues after stroke is high and persists over time, confirming the importance of OSA screening and management (Seiler et al., 2019).

OSA Compliance and Management Patient Challenges

Once diagnosed with OSA, engaging patients to follow through with treatment can be challenging. Two studies utilized telemedicine visits between office visits to assist with OSA treatment adherence and were successful (Carlucci & Thanavaro, 201; Kotzian et al., 2019). Additional studies stressed the importance of follow-up and keeping the patient engaged in their treatment to improve compliance, but did not provide specifics on how best to approach this problem (Colelli et al., 2018; Patil et al., 2019). Patient compliance remains a significant barrier to improving OSA management. An emphasis on education can improve compliance, but unfortunately, sometimes it is not enough to engage a patient to follow through with recommendations (Dharmakulaseelan et al., 2019).

Evidence Discussion

Through a review of the literature, the connection between OSA and stroke is evident. Many studies have shown not only a correlation between OSA and stroke but the importance of identifying and treating this modifiable stroke risk factor (Davis et al., 2013; Donald et al., 2018; Gupta et al., 2018; Rao et al., 2016; Schipper et al., 2016). The significance of OSA prevalence among stroke patients is also evident within the literature (Dong et al., 2018; Huhtakangas et al., 2018; Losurdo et al., 2018; Seiler et al., 2019). Identifying this connection between stroke and OSA and OSA prevalence within the literature established the foundation for the project.

Several themes emerged with regard to stroke and obstructive sleep apnea from the literature review. The importance of OSA screening was the dominant theme identified (Boulos et al., 2016, 2019; Ifergane et al., 2016; Katzan et al., 2016; Mohammad et al., 2018; Navalkele et al., 2016; Schipper et al., 2017; Severine et al., 2016; Skolarus et al., 2012). The gold standard for diagnosing OSA is through PSG (Kapur et al., 2017), but this is not always feasible within an acute care setting and often requires insurance approval prior to testing. Several studies offered alternative methods to screening patients for OSA using tools such as the STOP-Bang questionnaire, four-variable questionnaire, and Berlin questionnaire, all of which have proven validity and reliability (Boulos et al., 2016; Katzan et al., 2016; Severine et al., 2016).

Identifying patients at risk for OSA is elementary, but promoting the patient to follow through with treatment recommendations can be challenging. Influencing compliance with OSA treatment is another theme identified within the literature (Carlucci & Thanavaro, 2019; Colelli et al., 2018; Kotzian et al., 2019), although a limited amount of evidence was identified on how to best approach this problem. The evidence that was discovered on how to influence OSA treatment compliance is through education (Dharmakulaseelan et al., 2019; Donald et al., 2018; Holzemer et al., 2011), but again, there is limited evidence on how to implement an educational intervention. Despite those limitations, once stroke patients are identified at risk and treated for OSA, improved stroke risk factor management is achieved (Kernan et al., 2014; Kim et al., 2016; King & Cuellar, 2016; Schipper et al., 2017).

Evidence Strength

After reviewing the literature and excluding articles based on the inclusion and exclusion criteria, 32 articles formed the foundation for the inquiry and strengthened the evidence needed for the project. Two evidence-based practice guidelines, pertaining to stroke risk factor management and OSA management and treatment, added crucial evidential strength to the project. Five quantitative systematic reviews and meta-analyses strengthened the evidence by providing comprehensive information on OSA screening in stroke risk factor management. Also, six randomized controlled trials further strengthened the evidence of the project.

Evidence Limitations

Several limitations were identified in the literature. Many studies explicitly focused on stroke patients, not those who experience a TIA (Schipper et al., 2016). By excluding the patient population with TIA, patients at risk for OSA could be missed, and their stroke risk factors will not be optimally controlled. An additional limitation pertains to education and how to best educate stroke patients on OSA and the importance of OSA treatment. Many patients are simply not aware of the importance of OSA treatment and management (Schipper et al., 2016). Another potential limitation is that only eight out of the 32 studies included within the synthesis of evidence were conducted in the United States and the majority were from distant countries. Additionally, eleven of the 32 studies had 100 or fewer study participants, limiting outcomes or skewing results.

Evidence Gaps

A few gaps were identified in the literature relating to the project. Obstructive sleep apnea diagnosis and treatment compliance were identified themes within the literature, but there were limited findings on actions to improve patient compliance and adherence to therapy. This gap within the literature negatively affected the project. Also, the focus of stroke risk factor management within the literature typically did not include OSA evaluation unless the researcher focused specifically on OSA. The project leader was able to close this gap and included OSA screening within current stroke risk factor management.

Theory

The Health Promotion Model (HPM) is the theoretical model that was utilized for the project. This middle range nursing theory has been utilized over the last several decades by the nursing profession. This model was designed to improve health, enhance functional ability, and improve quality of life (Petiprin, 2016). There are three major concepts or components within the HPM; individual characteristics and experiences, behavior specific cognitions and affect, and behavioral outcomes (Pender et al., 2011). By incorporating all three concepts within the theory and the additional concepts of health promotion, secondary disease prevention, and health literacy, a health promoting behavior is achievable. The desired outcome of the project was to promote health, which aligns with the HPM concepts (see Appendix E, Diagram of the Health Promotion Model). The intervention goal was to identify stroke patients' OSA risk by using the STOP-Bang questionnaire and improving stroke risk factor management while integrating their health literacy.

Sevinc and Argon (2018) utilized the HPM in their pretest-posttest, quasi-experimental study on post myocardial infarction patients and observed a statistically significant difference between the control group that received standard care and the intervention group that received care based on the HPM. Individuals within the intervention group exemplified improvement in several laboratory studies, functional capacity, and self-efficacy, thus concluding the HPM was a useful program for their post myocardial infarction patients (Sevinc & Argon, 2018). An additional study by Hussein et al. (2017) utilized the HPM to manage hypertension in adults and produced similar results. Individuals within the intervention group showed statistically significant improvement in blood pressure measurement after implementing HPM (Hussein et al., 2017).

Methods

IRB and Site Approval

Institutional Review Board (IRB) approval was obtained from the project site. The IRB determined the project was not research, but a quality improvement project, and approval to proceed was granted on June 2, 2020 (see appendix F, IRB Approval Letter).

Ethical Issues

Primary ethical considerations must be considered for any evidence-based quality improvement (EBQI) project or research study including do no harm, anonymity, confidentiality, and respect for privacy (Fouka & Mantzorou, 2011). Throughout the project, maintaining participants confidentiality and privacy remained a priority of the project leader. Participant names were not recorded. Instead, participants were provided with an identification number to ensure post-data PSG and continuous positive airway pressure (CPAP) results were aligned with the correct participant. The STOP-Bang questionnaire hard copies were stored within a locked cabinet and shredded once entered within the data collection template. The project leader was sensitive to participant culture, diversity, and health literacy during the project. There were no vulnerable participants for this project. The project leader had no research conflicts to disclose.

Funding

The total estimated cost of the project was roughly $14. Costs included printed copies of the STOP-Bang questionnaire, education material for participants, informational letters about the project, and additional office supplies (see Appendix G, Cost Table for Project). The project leader’s time was donated for the project. Other providers who evaluated patients within the outpatient setting also donated their time at no additional cost.

Setting and Participants

The project was implemented at a local hospital. Inclusion criteria included participants greater than 18 years of age, radiographically diagnosed with an ischemic or hemorrhagic stroke during their hospital stay. Once initial inclusion criteria were met and OSA diagnosed, participants who chose treatment with CPAP continued in the project. Exclusion criteria included patients less than 18 years, diagnosed with a TIA, a previous diagnosis of OSA prior to stroke, and palliative or hospice care during their hospital stay. The project leader provided accommodations for non-English speaking participants through an interpreter phone system within the hospital setting as the STOP-Bang questionnaire is only available in English.

A convenience sample was obtained from stroke patients who received a neurology team consult and received direct care from the project leader during their hospital stay. The anticipated number of participants was 70 during the six-month data collection period.

Evidence-Based Practice Intervention

The project aimed to identify OSA risk and improve stroke risk factor management in stroke patients. The goal was to reduce recurrent stroke events and promote health by improving stroke risk factor management. Project participants diagnosed with a stroke from radiographic imaging during the proposed project timeframe were screened for OSA risk and referred for PSG if appropriate. Participants diagnosed with OSA were followed in the clinic to ensure their OSA was fully treated. The perceived outcome was once OSA was treated, stroke risk factor management improved.

Evidence-Based Intervention Protocol

Recruitment of participants was done using convenience sampling on the project leader's workdays during the proposed data collection timeframe (see Appendix H, Project Timeline Flow Graphic). Individuals radiographically diagnosed with stroke were provided a brief synopsis on the proposed project. Those willing to participate were provided with an information letter discussing the project (see Appendix I, Informational Letter) and education on the importance of stroke risk factor management and OSA screening (see Appendix J, Education Material 1).

Participant's OSA risk was assessed utilizing the STOP-Bang questionnaire (see Appendix K, STOP-Bang Questionnaire). The STOP portion of the questionnaire (snoring, tired, observed pauses, and blood pressure treatment) was obtained by interviewing the participant. The Bang portion of the questionnaire (BMI, age, and gender) was obtained by the project leader from the electronic medical record system and the neck circumference was measured by the project leader during the initial encounter with the participant. Those identified at high-risk for OSA with three or more yes items were referred for PSG.

Once PSG was completed, participants were to follow up in the clinic with the project leader or another provider within the office to review their results. Those diagnosed with OSA, based on an apnea-hypopnea index (AHI) of greater than five, were provided OSA education and treatment options by the project leader or other provider (see Appendix L, Education Material 2). Participants who chose CPAP were asked to continue in the study. After approximately 30 days of initiation of CPAP, participants were reevaluated in the clinic by the project leader or other provider. A CPAP download was obtained to assess for improvement of AHI from initial PSG to treatment with CPAP. An AHI of less than five confirms OSA is adequately being treated. Once all data was collected, the project leader pursued analysis and dissemination of results (see Appendix M, Intervention Flow Diagram).

Three separate formulas (Flesh-Kincaid, Fry, and Raygor) were used to identify the readability level of the informational letter and both educational materials utilized in the project

(“Readability Formulas”, n.d.). The informational letter was graded at grade 12 for Flesh-Kincaid, grade 13 for Fry, and grade nine for Raygor (“Readability Formulas”, n.d.). The educational materials on stroke risk factor management and OSA screening were graded at grade nine for Flesh-Kincaid, grade 14 for Fry, and grade six for Raygor (“Readability Formulas”, n.d.). The educational materials on OSA education and treatment were graded at grade nine for Flesh-Kincaid, grade 10 for Fry, and grade six for Raygor (“Readability Formulas”, n.d.).

Change Process Model and Evidence-Based Practice Model

Kotter and Cohen’s model of change was utilized to influence sustainability at the organizational level. Kotter and Cohen (2012) identified eight steps for successful change within an organization: urgency, team selection, vision and strategy, communicating the vision, empowerment, interim successes, ongoing persistence, and nourishment. This model exhibits easy progression between steps while focusing on preparing and accepting change (Aziz, 2017).

For this project, Stetler’s Model of Evidence-Based Practice was also utilized. Stetler’s Model of Evidence-Based Practice focuses on quality improvement efforts through research utilization (Stetler, 2001). This process model is utilized to describe and guide the process of translating research into practice (Nilsen, 2015). This model emphasizes evidence evaluation through critical thinking and logical process (Schaffer et al., 2013). Stetler (2001) identified five phases which include preparation, validation, comparative evaluation/decision making, translation/application, and evaluation. The model phases were developed to promote the use of research findings safely and effectively (Stetler, 2001).

By following Kotter and Cohen’s model of change (2012) and Stetler’s Model of Evidence-Based Practice (2001), the sustainability of the project was enhanced. The project leader conveyed results of identified OSA risk and stroke risk factor management to the neurology team and the organizational leaders at the project site. Positive results further solidified the need for continuing to integrate this project within the current system.

Project Design

This quasi-experimental, non-randomized, one cohort, pre- and post- test project focused on identifying OSA risk and improving stroke risk factor management. This intervention-based study emphasized screening stroke patients for OSA risk via the STOP-Bang questionnaire. Once identified at risk, education was provided on the importance of stroke risk factor management, specifically focusing on OSA management and treatment. Individuals that followed through with treatment recommendations were monitored and followed up within the clinic setting, where they were evaluated for improved OSA management, thus improving stroke risk factor management. Through statistical analysis, the primary outcome of OSA risk and secondary outcome of improved stroke risk factor management were evaluated by the project leader. This specific study design was chosen based on the project and the desired outcomes of the study (see Appendix N, Logic Model).

Validity

Aspects of both internal and external validity are identifiable within the project. By utilizing the STOP-Bang questionnaire with established validity and reliability (Amra et al., 2018; Chung et al., 2008; Katzan et al., 2016; Severine et al., 2016), internal validity was strengthened. Additionally, internal validity was reinforced by utilizing the evidence-based practice guidelines on stroke risk factor management and OSA management and treatment. Internal validity was also be enhanced as only the project leader implemented the screening intervention and collected the data for analysis, thus limiting the potential for data collection errors. A threat to internal validity included participants not following through with all aspects of the proposed project. External validity was enhanced secondary to convenience sampling, which increases the transferability of the intervention to the general population.

Outcomes

The primary outcome measure of the EBQI project was the identification of OSA risk from the STOP-Bang questionnaire in stroke patients. The secondary outcome was improved stroke risk factor management. This outcome was addressed by evaluating for improved AHI from the initial PSG compared to the approximate 30-day follow-up AHI obtained from a CPAP download. Once OSA was treated, this modifiable stroke risk factor was controlled, improving stroke risk factor management.

Measurement Instruments

The primary measurement tool utilized was the STOP-Bang questionnaire. This questionnaire has established validity and reliability in identifying OSA risk in stroke patients (Katzan et al., 2016) and generalizability to the general population in identifying OSA risk (Amra et al., 2018; Chung et al., 2008). During the development of the STOP-Bang questionnaire Chung et al. (2008) noted 83.6% sensitivity for individuals with an AHI between five and 14, 92.6% sensitivity for individuals with an AHI between 15 and 29, and 100% sensitivity for individuals with an AHI greater than 30 in predicting OSA. A systematic review by Amra et al. (2018) reviewed 13 studies that utilized the STOP-Bang questionnaire in identifying OSA risk. Ten of those studies further validated the questionnaire by PSG, showing specificity of 74.7% in detecting moderate OSA.

Additionally, Katzan et al. (2016) noted a statistically significant sensitivity of .94 and specificity of .50 from the STOP-Bang questionnaire administered to ischemic stroke patients. Participants with three or more yes answers to the questionnaire are considered at risk for OSA.

This questionnaire is within the public domain; therefore, permission to utilize the tool was not required. The readability level of the STOP-Bang questionnaire was unable to be determined from using Flesh-Kincaid, Fry, or Raygor as the questionnaire is less than 100 words (“Readability Formulas”, n.d.). This did not affect data collection as the project leader verbally read the questionnaire to participants.

Once identified at risk for OSA from the STOP-Bang questionnaire, willing participants were referred for a PSG, the gold standard for diagnosing OSA (Kernan et al., 2014). Participants with an AHI of greater than or equal to five obtained from the PSG were formally diagnosed with OSA (Kapur et al., 2017). Obstructive sleep apnea treatment was established by an improved AHI after CPAP initiation. Confirmation of AHI improvement was obtained from a CPAP download after approximately 30 days of use and compared to the initial AHI from the PSG. By treating this modifiable stroke risk factor, OSA, improved stroke risk factor management was achieved in the study.

Quality of Data

The promotion of quality data was implemented through several methods. A power analysis through G*Power using the correlation point biserial model with a power of .8, medium effect of .3, and alpha of .05 indicated a sample size of 64 was needed (Heinrich-Heine-Universität Düsseldorf, 2020). Baseline data and post data were collected by the project leader and placed within the data collection table (see Appendix O, Data Collection Table). Baseline data collection included gathering demographic data (age, gender, and race), stroke type (ischemic or hemorrhagic), and administering the STOP-Bang questionnaire to participants. Participant need for PSG was recorded as either yes, no, or declined. Post data collection of AHI was collected after the PSG and again approximately 30 days post CPAP initiation.

Additionally, the project leader recorded the participant's treatment choice (CPAP, oral appliance, surgery referral, or declined treatment). The leader collected baseline and post data for the duration of the data collection. The results were compared to published benchmark studies to strengthen the reliability of the findings (Huhtakangas et al., 2018; Katzan et al., 2016; Losurdo et al., 2018; Menon et al., 2017; Mohammad et al., 2018; Severine et al., 2016) and a systematic review (Dong et al., 2018).

Analysis Plan

Statistical analysis was conducted using IBM SPSS statistic software version 26 (Appendix P, Statistical Analysis SPSS Template Variable/Data View). Descriptive statistics were applied to describe the demographic data and findings. A Pearson Correlation Test was completed on scale data to assess for potential correlation between variables. An Eta Coefficient Test was completed on STOP-Bang scores and each additional variable to assess for a relationship between the variable and the STOP-Bang score. Correlations between STOP-Bang scores and PSG AHI and initial PSG AHI and post CPAP means were not analyzed due to sample size. Demographic data collected included, age, gender, and race.

Results

Setting and Participants

The study took place at a local 285-bed hospital. Data for the project was collected from August 1, 2020 to January 31, 2021. Over these six months, 67 participants met the inclusion criteria and were screened for OSA risk using the STOP-Bang questionnaire. There were 31 male (46.3%) and 36 female (53.7%) participants. They ranged in age from 41 to 99 years with a mean of 71.52 and standard deviation of 12.55. The majority of the participants were Caucasian at 82.1% (n=55), followed by African American at 10.4% (n=7), Asian at 6% (n=4), and

Hispanic at 1.5% (n=1). Most of the participants experienced an ischemic stroke at 92.5% (n=62), where only 7.5% (n=5) experienced a hemorrhagic stroke (see Appendix Q, Statistical Analysis Tables, Table 1).

Intervention Course

The project leader identified eligible participants for the project by utilizing the inclusion and exclusion criteria as previously established. Once a participant was identified as eligible to participate, they were provided with an informational letter discussing the project and their role within the project. Sixty-seven participants were screened for OSA risk via the STOP-Bang questionnaire. All participants were provided education on the connection between OSA risk and stroke by the project leader before screening. A referral for PSG was discussed with those identified at risk for OSA with a STOP-Bang score of three or greater. The PSG referral was sent to the project site's sleep lab to be scheduled for those willing to complete the PSG. Out of the 46 participants who qualified for a PSG, only 14 agreed to complete the PSG. Of those 14, only one participant completed the PSG within the six-month data collection. This participant was provided additional education post PSG, set up with CPAP, and then followed in the clinic setting for ongoing OSA management.

Outcome Data

The primary outcome of this project was to identify OSA risk among stroke patients by utilizing the STOP-Bang questionnaire. To be considered at risk for OSA, participants needed to score three or more on the STOP-Bang questionnaire. Participants with a score greater than or equal to three accounted for 68.7% (n=46) of participants and those with a score less than three accounted for 31.3% (n=21) of participants. Of the participants at risk for OSA, 20.9% (n=14) agreed to a PSG and 47.8% (n=32) declined a PSG. Twenty-one (31.3%) of the 67 participants were not at risk for OSA based on their STOP-Bang score (see Appendix Q, Statistical Analysis Tables, Table 1).

The secondary outcome was to improve stroke risk factor management by identifying OSA risk and OSA management. The project identified 68.7% (n=46) of the stroke patients were at risk for OSA. This intervention has fostered improvement in identifying OSA risk at the project site, which decreased stroke risk factors, thus improving stroke risk factor management. Additionally, for the one participant who completed a PSG, the initial AHI was 32.7 and post CPAP use AHI was 1.5. This participant improved their stroke risk factors by treating their OSA, improving their stroke risk factor management.

Two statistical analyses were completed to evaluate for correlations between variables. A Pearson correlation test revealed no significant correlation between age and STOP-Bang scores (see Appendix Q, Statistical Analysis Tables, Table 2). An Eta Coefficient test showed a strong correlation between referral and STOP-Bang score, meaning when the STOP-Bang score increased, there was an increase in the participant declining a PSG (see Appendix Q, Statistical Analysis Tables, Table 3). An additional Eta Coefficient test revealed a possible correlation between gender and STOP-Bang score (see Appendix Q, Statistical Analysis Tables, Table 4). When evaluated further, 90.3% (n=28) of the male participants scored a three or greater on the STOP-Bang questionnaire, leaving 9.7% (n=3) with a score less than three. The female participants were divided evenly at 50% (n=18). Fifty percent (n=18) scored greater than or equal to three, and the other 50% (n=18) scored less than three on the STOP-Bang questionnaire. No correlation was identified between race and STOP-Bang score and no correlation identified between stroke type and STOP-Bang score (see Appendix Q, Statistical Analysis Tables, Tables 5 and 6). There was no missing data.

When initially screening participants for the project, one of the exclusion criteria was a previous diagnosis of OSA and 17 stroke patients were excluded for this reason. Of those 17 stroke patients, 64.7% (n=11) knew they had a diagnosis of OSA, but had chosen not to treat their OSA. The remaining six stroke patients (35.3%) treated their OSA with CPAP or had previous OSA surgery, such as a uvulectomy.

Discussion

Successes

The project was successful because it fulfilled the primary outcome by identifying that 68.7% of the participants were at risk for OSA. Another success was that the project strengthened the need for ongoing screening of OSA risk among stroke patients at the project site due to the high percentage of participants identified at risk for OSA. Additionally, the majority of the stroke patients screened for OSA risk had never thought of OSA as a stroke risk factor. This lack of knowledge provided the project leader the perfect opportunity to provide additional education on all stroke risk factors, the importance of managing them, and potential adverse events if not managed properly.

Study Strengths

The project setting provided strength to the project. The Stroke Coordinator and additional providers were eager to help with the project. They were willing to alter their schedules if needed for patients to be seen in follow-up promptly, make follow-up phone calls to participants if needed, and complete any additional office paperwork required for PSG referrals.

All eligible participants were willing to complete the STOP-Bang questionnaire and engaged in the educational session provided after their screening. While a majority of the participants eligible for PSG declined to complete it, they all verbalized understanding and appreciation of the importance of the PSG, the value of the project, and expressed intent to discuss their OSA risk with their primary care provider in the future for possible reconsideration of completing a PSG.

Results Compared to Evidence in the Literature

The synthesis of evidence revealed several studies that showed a significant prevalence of OSA among stroke patients. Severine et al. (2016) screened 291 stroke and TIA patients for OSA risk utilizing the STOP-Bang Questionnaire. Their results identified 88% (n=257) of the patients were at risk for OSA, while 11.7% (n=34) were not at risk for OSA. Mohammad et al. (2018) utilized a different screening tool, The Berlin Questionnaire, and identified a 55% prevalence of OSA among their study participants.

Several studies utilized a screening tool and PSG for confirmatory testing to diagnosis OSA among stroke patients. Katzan et al. (2016) used a variation of the STOP-Bang Questionnaire, the STOP-Bag Questionnaire, and PSG and diagnosed 61% of their 208 participants with OSA. Menon et al. (2017) screened 99 stroke patients for OSA risk utilizing the Epworth Sleepiness Scale followed by PSG. They noted a 60% OSA prevalence with 25 percent having severe OSA among their study participants. Losurdo et al. (2018) evaluated 140 first-ever ischemic stroke patients for OSA and dysphagia. They utilized a cardiorespiratory sleep study and diagnosed 51.4% (n=72) of their study participants with OSA and 57.8% (n=81) with dysphagia based on the Gugging Swallowing Screen scale. Huhtakangas et al. (2018) screened 177 stroke patients for OSA using a PSG and diagnosed 89.9% (n=159) with OSA. They reevaluated the participants again for OSA at six months, finding the OSA prevalence increased to 92.7% (n=164) six months post stroke.

The diagnosis of stroke is considered a type of cerebrovascular disease (CVD). Dong et al. (2018) completed a systematic review on the prevalence of OSA in patients with CVD. They analyzed 37 studies and noted the pooled prevalence of OSA was 61.9%.

Studies have shown a prevalence of OSA among stroke patients. The prevalence ranges from 50% to 90%. These findings coincide with the project results of 68.7% of stroke patients demonstrating an increased risk for OSA.

Limitations

Internal Validity Effects

A few potential threats could impact internal validity. The project leader was the only one collecting and inputting data. This collection could present bias, but because only one individual was responsible for data collection, it limited data collection errors. Another threat to internal validity is that only one study participant completed a PSG although, 14 participants at risk for OSA were willing to complete a PSG. Due to time constraints of the project, delay in referral approval from insurance, or cost to the participant, only one participant completed a PSG. Lack of PSG completion affected the study outcomes as the project leader could only discuss the STOP-Bang score with PSG results and CPAP use with that one participant. Comparing those variables between multiple participants would have further strengthened the study results.

External Validity Effects

External validity threats affected the transfer of the intervention to other settings. The majority of the population screened was Caucasian at 82.1%, not representative of the local ethnic population. Additionally, the sample size of 67 participants and the short duration of data collection affects external validity. Gender was relatively evenly divided with 46.3% male and

53.7% female, which favors the transfer of the intervention to the local population and strengthens external validity.

Sustainability of Effects and Plans to Maintain Effects

Since stroke factor modification is already a part of every stroke patient's discharge planning at the project site, continuing to include OSA screening and education should be sustainable. A sample of the STOP-Bang Questionnaire is readily available for the Stroke Coordinator and neurology team, along with the education material on OSA and its connection to stroke. Patients identified at risk for OSA will be recommended to discuss these results with their primary care provider or neurologist at their hospital follow-up visit.

Efforts to Minimize the Study Limitations

One study limitation was patients declining PSG once being identified at risk for OSA. The project leader attempted to minimize this limitation by discussing the findings with the participant again during their post hospital discharge office visit. If no office visit was scheduled or if they no-showed for their office visit, the project leader attempted to phone the participant and rediscuss their OSA risk and encourage them to complete a PSG. Where all participants who initially declined a PSG did decline again, the project leader encouraged the participants to discuss further their OSA risk with their primary care providers and reconsider evaluation in the future.

Interpretation

Expected and Actual Outcomes

The expected outcomes were identification of OSA risk in stroke patients and improved stroke risk factor management. The actual outcome identified that 68.7% were at risk for OSA. The identification of OSA risk fostered improvement in identifying OSA to improve stroke risk factor management. An unexpected result pertained to the strong correlation between an elevated STOP-Bang score and declining a referral for PSG. The correlation between these two variables is not clear but could be explored in a future research study. Another unexpected outcome was that 11 of the 17 stroke patients excluded from the project secondary to a previous OSA diagnosis knew they had a diagnosis of OSA and were purposefully not receiving treatment.

Intervention Effectiveness

The project was effective in identifying OSA risk in stroke patients. The OSA risk screening and initial OSA and stroke education took place in their hospital room. This was an ideal setting to screen and educate them as most were waiting for other tests or resting and recovering from their stroke, which allowed for ample time to participate in the project. Several patients also had family members in their room encouraging them to participate in the project. As for potential other settings, this intervention could easily be implemented during an outpatient office visit.

Intervention Revision

To improve the attainment of outcomes, collecting data for a longer period would be useful. Several participants were screened just before the end of the data collection timeframe, which did not allow for enough time to schedule a PSG or additional follow-up. For those participants who initially declined a PSG and were not seen in the office setting for a follow-up visit, a phone call was made to rediscuss their OSA risk. Only one phone call was made to each qualifying participant. Perhaps reaching out to the participant for a second time via phone or letter by mail would have shown a different outcome.

Expected and Actual Impact to Health System, Costs, and Policy

The expected impact of this project was to improve stroke risk factor management by identifying OSA risk in stroke patients. The results showed 68.7% of participants screened were at risk for OSA. By identifying OSA risk, there is a positive impact on the health care system to potentially decrease future costs of readmissions and stroke recurrence. At the project site, stroke risk factors were already being addressed for every stroke patient, so adding OSA screening added little to no additional cost, strengthening its economic sustainability. The estimated and actual cost of the project were equivalent, around $14, which was mainly for printing the STOP-Bang questionnaire and education materials. There was no significant economic cost added to the health care system by implementing the project, therefore enhancing its sustainability. There was no outside funding needed for this project.

Conclusion

The overall practical usefulness of the project is significant. Integrating OSA screening to stroke patients using the STOP-Bang questionnaire provides a substantial opportunity to improve patient's health by promoting disease prevention and providing quality healthcare. The neurology team and Stroke Coordinators will have an additional step when addressing stroke risk factor management at hospital discharge for stroke patients, but adding this step to the established hospital discharge protocol will be easy and straightforward. Additional responsibility will fall on the identified OSA risk patient, as they will need to follow through with further OSA evaluation and treatment recommendations once discharged from the hospital.

There are opportunities for additional outcome studies. It would be interesting to look into why there was a correlation between a high STOP-Bang score and denial of a PSG. Another opportunity could be to identify the barriers in place that hindered participants willingness to obtain a PSG or why those with a previous diagnosis of OSA chose not to adhere to previously recommended treatment. Additionally, one could follow participants with treated OSA for several years to see if they exhibited a decrease in stroke recurrence once OSA was treated, as the project suggests should occur.

Dissemination of this project was completed on August 22, 2020. During the American Association of Neuroscience Nurses/International Neuroscience Nurses Research Symposium, the project leader presented a proposal poster presentation at the virtual conference. Additionally, the results were presented at the project site to the neurology team and Stroke Coordinators with additional plans to present to administration.

The impact of improved stroke risk factor management is significant for patients, their families, and the healthcare system. By screening stroke patients for OSA risk, the healthcare provider has the potential to identify a modifiable stroke risk factor. Treated OSA in stroke patients improves the management of stroke risk factors and aids in stroke recovery, decreases the risk of future stroke events, improves patient’s quality of life, and decreases the burden on the healthcare system.

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Appendix A

Definition of Terms

Stroke: A medical emergency where blood flow to the brain is interrupted causing damage. Types of stroke include ischemic, hemorrhagic, and cryptogenic (American Stroke Association, 2020).

Obstructive Sleep Apnea (OSA): Intermittent blockage of airflow during sleep causing drops in oxygen saturation and pauses in breathing.

Secondary stroke prevention: Treatment of stroke risk factors in individuals already diagnosed with stroke.

STOP-Bang questionnaire: OSA risk screening tool with eight yes/no questions, containing both subjective and objective data. Three or more yes items indicate a high risk for OSA.

Polysomnography (PSG): Gold standard study used to diagnose sleep disorders

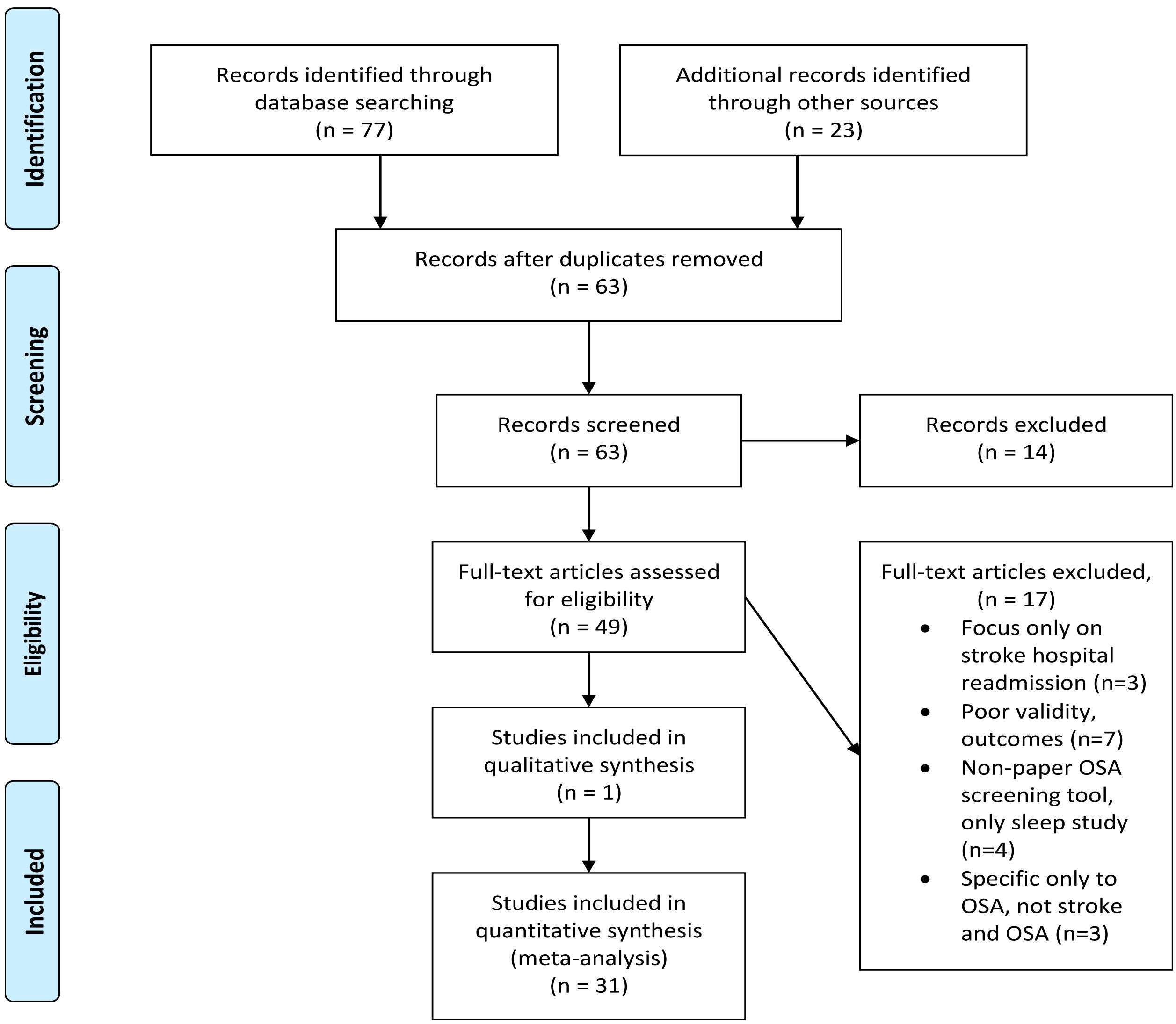
Apnea-hypopnea index (AHI): Measurement of complete (apnea) and partial (hypopnea) pauses in breathing per hour during sleep (American Academy of Sleep Medicine, 2008). Able to obtain AHI from PSG and CPAP downloads. Objective data monitored as evidence of OSA management.

Continuous Positive Airway Pressure (CPAP): A treatment option for OSA management. Provides positive airway pressure continuously to keep the airway open. CPAP machines can measure AHI and produce additional information to assist in OSA management.

Appendix B

PRISMA Diagram

PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org

Appendix C

Synthesis of Evidence Table

First author, Year, Title, Journal	Purpose	Research Design[1], Evidence Level[2] & Variables (IV, DV)	Sample & Sampling, Setting	Measures & Reliability (if reported)	Results & Analysis Used	Limitations & Usefulness
Subtopic: OSA screening						
Boulos, M. I. (2019). Using a modified version of the STOP-Bang questionnaire and nocturnal oxygen desaturation to predict obstructive sleep apnea after stroke or TIA. Sleep Medicine.	- Examine the use of a modified version of the STOP-Bang questionnaire to diagnose OSA - Removed neck circumference, added nocturnal oxygen desaturation - Goal to improve accuracy in OSA diagnosis	- Quantitative, cohort study without randomization - Level III - IV: STOP-Bag questionnaire, O – nocturnal oxygen desaturation - DV: A valid tool in identifying OSA is STOP-Bag-O	- 231 participants diagnosed with stroke/TIA, completed STOP-Bag questionnaire and sleep study - Convenience sampling – taken from 2 clinical trials - Researchers location - Canada	- STOP-Bag-O - STOP-Bag questionnaire - in lab or home sleep study	- OSA diagnosis of AHI ≥ 10, STOP-Bag sensitivity and specificity of 83.5% & 67.2%. STOP-Bag-O sensitivity and specificity of 95.9% & 78.4% - For all AHI cut-offs, STOP-Bag-O was greater statistically different compared to STOP-Bag	- Limitation: patients were excluded if had aphasia or severe physical impairment, so may not be able to apply results to severe stroke patients - Patients recruited from single-center and part of clinical trials, limiting generalizability - Realistic use
Zhang, L. (2019) Application of neck circumference in four-variable screening tool for early prediction of obstructive sleep apnea in acute ischemic stroke patients.	- Identify OSA risk in stroke/TIA patients using four-variable screening tool (4V) and modified 4V tools - Validating tools	- Cohort study - Level IV - IV: 4V tool and modified 4V tools - DV: 4V and modified 4V comparable in identifying OSA risk in stroke/TIA patients	- 124 participants completed sleep study and filled out all questionnaires - Convenience sampling - Setting: China	- 4V tool - Modified 4V tool - STOP-Bang questionnaire - Berlin questionnaire - Epworth Sleepiness Scale - Sleep study	- Modified 4V-1/4V-2 is useful for the OSA screening if BMI not available. - SPSS version 23.0 and MedCalc version 17.9.5	- Limitations: Small sample size - Useful for identification of an additional OSA screening tool
Amra, B. (2018) Screening questionnaires for obstructive sleep apnea: An updated systematic review	- Literature review - Evaluating the reliability of OSA screening tools compared to sleep study	- Systematic review - Level I - IV: OSA screening questionnaires - DV: Reliable tools for OSA screening -	- Reviewed 39 studies - Sampling from studies specifically on OSA screening - Setting: Iran	- Berlin Questionnaire (BQ) - SQ - SBQ	- Reliable screening tools for OSA - SQ and SBQ - Highest sensitivity in identifying OSA was SQ	- Limitations: only on sleep patients, not specifically stroke patients - Usefulness: Despite limitation, still useful,

		STOP Questionnaire (SQ) & STOP-Bang Questionnaire (SBQ)		- Epworth Sleepiness Scale (ESS)		showing reliability of SQB tool
Mohammad, Y. (2018). Stroke during sleep and obstructive sleep apnea: there is a link. Neurological Sciences	Determine the relationship between OSA and wake up stroke	- Case-control study - Level IV - IV: Berlin questionnaire - DV: OSA risk evident in wake-up stroke patients	- 107 patients - Convenience sampling - Setting: Saudi Arabia	- Berlin questionnaire	- OSA is highly prevalent in patients with wake-up strokes - 55% prevalence OSA among stroke patients, clustered around wake-up strokes - Analysis: Logistic regression, STATA 12	- Limitations: only used the Berlin questionnaire and not sleep study to identify OSA - Realistic use
Boulos, M. I. (2016). Identifying obstructive sleep apnea after stroke/TIA: evaluating four simple screening tools. Sleep Medicine.	- To exclude OSA risk after stroke/TIA by evaluating four simple paper-based screening tools.	- Quantitative, cohort study without randomization - Level III - IV: paper-based OSA screening tools - DV: screening tools identify OSA in stroke patients	- 69 stroke/TIA patients – inpatient and outpatient - Convenience sampling - Setting – Sunnybrook Regional Stroke Prevention Clinic, Canada	- 4-variable screening tool - STOP-Bag - Berlin questionnaire - Sleep Obstructive apnea score optimized for stroke - Sleep study	- 4V and STOP-Bag questionnaires may aid clinicians with ruling out OSA in stroke/TIA patients - Analysis – t-tests, Wilcoxon rank-sum test, multivariable logic regression	- Limitations: out of sleep lab sleep studies are not the gold standard for identifying OSA, misclassification of OSA may have occurred; patients with significant physical impairment excluded; STOP-Bag limited secondary to neck circumference left out - Realistic use
Ifergane, G. (2016). Obstructive sleep apnea in acute stroke: A role for systemic inflammation. Stroke.	- Evaluate clinical characteristics, lab inflammatory biomarkers, coagulability associated with OSA severity during acute post-stroke period	- Prospective, cohort study - Level IV - IV: Bed-side WatchPAT, 3 biomarker levels - DV: OSA identified, elevated biomarkers	- 42 acute stroke patients - Convenience sample - Setting -Soroka University Medical Center, Israel	- Bed-side WatchPAT – reliable alternative to polysomnography - 3 biomarker levels (tumor necrosis factor, interleukin-6, plasminogen activator inhibitor-1	- 90% had sleep-disordered breathing - Possible pathophysiological explanation of OSA-associated stroke risk based on increased levels of inflammatory biomarkers	- Limitations: a single-institute study with a relatively small sample size - Realistic use

					- Analysis: Student t-test, Bonferroni correction	
Katzan, I. (2016). A screening tool for obstructive sleep apnea in cerebrovascular patients. Sleep Medicine.	- Evaluate existing OSA screening tools and understand the framework of ones frequently used in stroke patients	- Retrospective, cohort study - Level IV - IV: Sleep study results. Questionnaire's - STOP, STOP-Bang, STOP-Bag, STOP-Bang2, STOP-Bag2 - DV: risk of OSA via screening correlates with the presence of OSA	- 208 patients with a mean age of 55.4, with 61% diagnosed with OSA - From ambulatory Cerebrovascular Clinic at Cleveland Clinic, OH from Jan 2011 to Dec 2012	STOP-Bang, STOP-Bag, STOP-Bang2, STOP-Bag2	- STOP-Bag screening tool showed good sensitivity & specificity in identifying OSA in cerebrovascular patients - STOP-Bag similar to STOP-Bang without neck circumference (NC), including NC, did not improve model performance - Mann-Whitney U test, Chi-squared test	- Limitations: retrospective study, possibly not generalizable secondary to referral bias for OSA evaluation - Usefulness: validates STOP-Bang and STOP-Bag tool in screening for OSA
Navalkele, D. D. (2016). Exploration of screening practices for obstructive sleep apnea in stroke medical community: A pilot study. Pathophysiology	Determine screening practices for sleep-disordered breathing (SDB) within the stroke medical community	- Non-randomized, quantitative descriptive - Level VI - IV: web-based survey - DV: screening practices for SDB	- 112 total responses to a web-based survey - Sampling from providers in stroke care - Setting: Germany	Web-based survey	- 72% of providers do not use SDB screening questionnaires in stroke patients	- Limitations: Generalizability restricted, non-response bias of 82%, - Realistic use
Severine, J. (2016). Screening for obstructive sleep apnea in hospitalized transient ischemic attack stroke patients using the STOP-Bang questionnaire. The Journal for Nurse Practitioners	Examine OSA risk utilizing the STOP-Bang questionnaire among hospitalized stroke/TIA patients	- Quantitative, well-designed control trial without randomization. - Level III. - IV: STOP-Bang questionnaire, NIHSS scores. - DV: TIA/stroke patients at risk for OSA vs not at risk	- 300 patients at the Comprehensive Stroke Unit and TIA/Stroke Census Database. - Convenience sampling. - Principal investigator's academic institution. US	STOP-Bang questionnaire, NIHSS score	- 88% of stroke patients were at risk for OSA, 11.7% of stroke patients had no OSA risk. - To describe sample/findings, descriptive analysis was used	- Limitations: Baseline OSA data before TIA/stroke was not all available. Contribution of OSA risk could have been altered because of the small sample size of just TIA patients & exclusion of patients with severe neurological damage

						- Realistic use
Schipper, M. H. (2016). Occurrence of obstructive sleep apnea syndrome (OSAS) in patients with transient ischemic attack (TIA). Journal of Stroke and Cerebrovascular Disease	Analyzed occurrence of OSAS in high-risk patients with TIA	- Cohort study - Level IV - IV: OSA screening, sleep study - DV: TIA patients OSAS occurrence	- 555 patients suspected of TIA were screened for OSA, 121 found at risk, but only 77 patients followed through with sleep study - Convenience sampling - Setting: TIA clinic, Netherlands	- Sleep study - Epworth Sleepiness Scale (ESS) - BMI - Yes/No to snoring	- TIA patients had a high occurrence of OSAS compared to patients without - Analysis was done with SPSS, Kolmogorov–Smirnov test	- Limitations: 44 patients refused sleep study; patients not aware of OSAS; only 3 questions used to screen (BMI, ESS, yes/no snoring) - Realistic use
Skolarus, L. E. (2012). Sleep apnea risk among Mexican American and Non-Hispanic white stroke survivors. Stroke.	- Determine the prevalence of screening, testing, and treatment of sleep apnea among stroke survivors - Compare actual sleep apnea risk to self-perceived risk	- Quantitative descriptive study - Level VI - IV: mailed survey - DV: how stroke survivors perceive their risk of OSA	- 193 respondents (49% response rate) - Sampling: stroke survivors in the Brain Attack Surveillance in Corpus Christi (BASIC) - Setting: Texas	- Berlin questionnaire - Asked about sleep apnea screening, formal sleep testing, treatment - McNemar's test to compare actual risk and self-perceived risk of sleep apnea	- 48% of respondents had a high risk of sleep apnea based on the Berlin questionnaire - 19% of respondents thought they were likely to have OSA	- Limitations: results based on self-report and may be inaccurate; sampling error may be present due to only 49% response
Subtopic: OSA & Stroke Risk Factor Management						
Gupta, A. (2018). Role of positive airway pressure therapy for obstructive sleep apnea in patients with stroke: A randomized controlled trial. Journal of Clinical Sleep Medicine	Assess the effect of CPAP treatment on prevention of new vascular events among patients with stroke and OSA	- Single-blind, randomized controlled study - Level II - IV: nightly CPAP treatment - DV: new vascular events in CPAP group vs non-CPAP group	- 70 participants (34 CPAP group, 36 non-CPAP group) - Sampling obtained from 116 reported sleep studies, took 83 with AHI > 15, but 13 couldn't be randomized secondary to no CPAP device, thus	- Sleep study - CPAP - Confirming additional vascular event (history, clinical exam, EKG, cardiac enzymes, brain imaging)	- Improved stroke outcomes on stroke recurrence in patients with stroke and OSA who use CPAP treatment - Analysis done with STATA version 12.0 statistical software, all categorical variables summarized as frequency (%)	- Limitations: Small sample size, 4 from the initial CPAP group had to move to the non-CPAP group. Concern for generalizability secondary to the majority of participants were young, male. - Realistic use. Those in the CPAP group did have fewer

			70 participants were used - Researchers location - India			vascular events than non-CPAP groups, though not statistically significant
Jehan, S. (2018). Obstructive sleep apnea and stroke. Sleep Medicine Disorders	To summarize the importance of OSA management as a risk factor of stroke	- Non-experimental, expert opinion - Level VII	N/A	N/A	OSA is a major risk factor for stroke, & all stroke/TIA patients should be screened for OSA	- Limitations: level VII article - Realistic use
Schipper, M. H. (2017). Stroke and other cardiovascular events in patients with obstructive sleep apnea and the effect of continuous positive airway pressure. Journal of Neurology	Examine if patients with treated OSA with CPAP have a lower risk for new cardiovascular events (CVE), as compared to untreated OSA.	- Cross-sectional study of OSA patients mailed a questionnaire, compliant with CPAP - Level IV - IV: CPAP compliance - DV: CPAP can reduce the risk of CVE	- 554 participants mailed back questionnaire or were talked to via phone call - Convenience sample of newly dx OSA patients - Setting -The Netherlands	- Sleep study - Questionnaire (general info – ht/wt, smoking, meds, hx of vascular disease (stroke/TIA, MI, DM, OSA) - CPAP treatment	- More CVE in untreated OSA patients with indication for CPAP - Analysis was done with SPSS version 22.0. Data analyzed for normal distribution using Kolmogorov-Smirnov test	- Limitations: Questionnaire-based, compliance for treatment not known between time of sleep study & questionnaire, only partial adjustment for other risk factors - Useful in that study showed patients who needed CPAP but were not compliant had significantly more CVE
Kim, Y. (2016). Can continuous positive airway pressure reduce the risk of stroke in obstructive sleep apnea patients? A systematic review and meta-analysis. PLOS One.	Evaluate the effects of CPAP on Evaluating the effect of CPAP on stroke incidence	- Systematic review and meta-analysis - Level I - IV: CPAP treatment in OSA patients - DV: CPAP use in OSA patients decrease the risk of stroke	- Systematic review and meta-analysis – 8 studies – 1 RCT, 5 cohort studies, 2 studies using administrative health data - Sample via literature search - Setting – Korea	- Systematic literature search and meta-analysis	- Treating OSA with CPAP might decrease stroke risk	- Limitations: limited number of studies met their criteria, only 8 - Useful in that they did discover treating OSA with CPAP might decrease the risk of stroke
King, S. (2016). Obstructive sleep apnea as an independent stroke	- Present evidence supporting OSA as an independent stroke risk factor	- Systematic literature search - Level I - IV: literature search	- Systematic literature search – 28 research articles reviewed – 14	- Systematic literature search	- OSA highly prevalent in stroke/TIA patients	- Limitations: limited time frame from 2003-2013, only 28

risk factor: A review of the evidence, stroke prevention guidelines, and implications for neuroscience nursing practice. Journal of Neuroscience Nursing	- Promote excellence in stroke/TIA care by engaging neuroscience nurses to add OSA assessment and interventions	- DV: OSA is prevalent in stroke/TIA patients independently increasing stroke risk	observational cohorts, 5 case-control studies, 4 cross-sectional studies, 4 RCT - Sample via literature search - Setting – Georgia		independently increasing stroke risk - Reduced stroke recurrence & improved recovery in CPAP studies - Improve stroke/TIA patient outcomes by empowering neuroscience nurses to integrate OSA initiatives	research articles were reviewed. - Realistic use
Kernan, W. N. (2014). Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack (TIA). Stroke.	Updated guideline on evidence-based recommendations for the prevention of future stroke among stroke and TIA survivors	- Systematic review and meta-analysis - Level I - IV: improve secondary stroke prevention - DV: recommended consideration of sleep study in stroke/TIA	- meta-analysis of 29 studies - Various settings	- Sleep study - Results from various screening tools - CPAP use & adherence	- Recommend considering sleep study for stroke/TIA patients secondary to a very high prevalence of sleep apnea in stroke/TIA patients - Improved outcomes with treated sleep apnea	- Limitations: latest guidelines for secondary stroke prevention, but from 2014 - Realistic use
Subtopic: Stroke & OSA Education						
Dharmakulaseelan, L. (2019). Educating stroke/TIA patients about obstructive sleep apnea after stroke: A randomized feasibility study. Journal of Stroke and Cardiovascular Diseases.	Develop and conduct a preliminary assessment of educational materials for post-stroke/TIA OSA.	- Blinded pilot study where stroke/TIA patients were randomized to either control or intervention group - Level II - IV: Educational pamphlet and slideshow - DV: Assess whether educational materials on sleep disorders was feasible/easy	- 48 participants (23 control group, 25 intervention group) - Sample obtained from patients with a stroke/TIA and expressing sleep complaints - Setting Stroke Program in Canada	- Educational pamphlet and adapted into a 5-minute animated slideshow - Baseline and 6 months follow up questionnaire to assess both groups	- No difference for baseline and 6-month follow up educational assessment	- Limitation: lack of statistical power; they recommend changes to educational materials to improve their effectiveness, not explicit enough to warn about the harmful effects of sleep apnea - Usefulness: not statistically significant results, but useful information on study set up/design

Donald, R.A. (2018). The effect of an educational pamphlet on patient knowledge of an intention to discuss screening for obstructive sleep apnea in the acute ischemic stroke population. The Journal of Neuroscience Nursing	Evaluate the effect of educational intervention on patient knowledge and interest in OSA screening.	- Non-randomized, single group, pretest/posttest study. - Level VI - IV: pre/post-intervention survey (intention to speak to a provider about OSA screening & perception of pamphlet's educational value) - DV: an educational pamphlet on OSA/stroke was or was not educational	- 124 eligible patients, 36 consented, only 26 completed both pre/post-intervention survey - Sample obtained from patients with documented ischemic stroke - Setting: Ohio	Pre/post-intervention survey	- Preintervention knowledge scores averaged 69.7%, post scores 80.8% - Likelihood of speaking to a physician about OSA testing improved from 3.5 to 5.0 - Pre/posttest comparisons for increased knowledge via paired t-tests - Analysis: Cohen's *d* effect size calculations to show improvement between baseline & intervention phases into more clinical context	- Limitations: small study size of only 26 participants; some aspects of their assessment were developed de novo; self-reported intention to speak to a provider about OSA screening is a "soft" outcome prone to bias - Realistic use
Holzemer, E. M. (2011). Modifying risk factors after TIA and stroke: The impact of intense education. The Journal for Nurse Practitioners	- Can individualized educational plans after TIA/stroke impact risk factors and lifestyle changes	- Randomized control design - Level II - IV: standard of care education vs individualized education - DV: individualized education improves attention to risk factors	- 52 patients - Convenience sampling - Setting: St Louis University Hospital	- Standard education - Individualized education	- Statistically significant improvement in risk factor modification with individualized educational intervention - Analysis: ANOVA, Mann-Whitney U	- Limitations: unknown if long term gains seen at 3 months would be sustained, small sample size - Realistic use
Subtopic: OSA & Stroke Recovery						
Ren, L. (2019). Effects of continuous positive airway pressure (CPAP) therapy on neurological and	To determine the impact of CPAP on rehabilitation in basal ganglia stroke patients with OSA	- Prospective, randomized controlled trial - Level II - IV: CPAP therapy vs no CPAP therapy	- 128 patients - Sampling from multicenter locations - Setting: China	- Sleep study - NIHSS - MMSE - Fugl-Meyer assessment scale for motor function	- Use of CPAP might improve neurological and cognitive dysfunction - Analysis: SPSS version 22.0,	- Limitations: CPAP compliance was low, small sample size, no blinding was used, possible selection bias as only basal ganglia

functional rehabilitation in basal ganglia stroke patients with obstructive sleep apnea. Medicine.		- DV: improved functional recovery with CPAP therapy		- Barthel index for ADL's - Hamilton anxiety scale & depression scale - BMI	Student's t-test, chi-square test	stroke patients selected - Realistic use
Bravata, D. M. (2018). Diagnosing and treating sleep apnea in patients with acute cerebrovascular disease. Journal of the American Heart Association.	Evaluated whether CPAP for OSA patients with stroke/TIA improved neurological severity and function status	- Randomized control trial - Level II - IV: diagnosis & treatment of OSA vs usual care - DV: CPAP improves neurological functioning among stroke/TIA patients with OSA	- 252 participants (84 control, 86 standard, 82 enhanced) - Convenience sampling - Setting – conducted at 5 hospitals at Yale School of Medicine and Indiana University School of Medicine	- Sleep study - Educational session via in person and over phone - Questionnaire about attitudes & beliefs about sleep apnea, social support - Self-Efficacy Measure in sleep apnea	- CPAP therapy for stroke/TIA patients with OSA had statistically significant improvements in neurological symptoms and functional status - Analysis: SAS/STAT software, Fisher's exact tests, ANOVA	- Limitations: some missing data secondary to losses of follow up, small sample size, took about 1 month for CPAP group to receive their device - Realistic use: prevalence of OSA in stroke/TIA patients was 76%
Menon, D. (2017). Impact of obstructive sleep apnea on neurological recovery after ischemic stroke: A prospective study. Acta Neurologica Scandinavica.	To determine prevalence, severity, and impact on stroke recovery of OSA in stroke patients	- Prospective single-center study, cohort - Level IV - IV: Effect of OSA on neurological recovery - DV: Neurological recovery based on the modified Rankin scale (mRS)	- 99 participants with acute ischemic stroke - Sampling from 389 stroke patients during the study period, based on exclusion criteria, 99 were selected - Setting – primary researchers institutional setting, India	- Sleep study - NIHSS - mRS score on neurological recovery	- 60% prevalence of OSA with 25% of them having severe OSA. - OSA group had higher mean NIHSS score at discharge and higher mRS score at all points of evaluation - Analysis – SPSS version 17.0	- Limitations: Validated Apnealink, used to diagnose OSA but can have a higher chance of false negativity. - Realistic use
Zhang, Y. (2017). Obstructive sleep apnea exaggerates cognitive dysfunction in	For stroke patients, Investigate the relationship between OSA and	- Quantitative, cohort study - Level IV - IV: OSA diagnosis, cognitive evaluation	- 44 participants - Convenience sampling from patients admitted during study	- Sleep study - Chinese version of the Cambridge Prospective Memory test	- Hypoxemia and sleeping discontinuity secondary to OSA contributes to cognitive dysfunction in stroke patients	- Limitation: small sample size, possible selection bias in the sample of non-stroke snoring patients, stroke patients were

stroke patients. Sleep Medicine.	cognitive impairment	- DV: OSA impact on cognitive function in stroke patients	timeframe with stroke - Setting - Kunshan Affiliated Hospital of Jiangsu University, China	- Epworth Sleepiness scale -Mini-mental status exam	- Analysis – SPSS version 19.0	older than non-stroke control patients - Realistic use
Subtopic: Stroke & OSA prevalence						
Seiler, A. (2019). Prevalence of sleep-disordered breathing after stroke and TIA. Neurology.	Systematic review and meta-analysis on the prevalence of sleep-disordered breathing (SDB) after stroke.	- Systematic review and meta-analysis - Level I - IV: OSA and stroke - DV: OSA is prevalent in stroke patients	- 89 studies included (54 studies performed in the acute phase after stroke, 23 studies sub-acute phase, 12 studies in the chronic phase) - Convenience sampling - Setting: Russia & Switzerland	- Systematic literature search and meta-analysis	- Prevalence of SDB after stroke and TIA is high and continues over time, therefore important and prevalent in this clinical setting - Analysis: quantitative synthesis from included studies	- Limitation: latency between stroke and SDB highly variable - Realistic use
Dong, R. (2018). Prevalence, risk factors, outcomes, and treatment of obstructive sleep apnea in patients with cerebrovascular disease: A systematic review. Journal of Stroke and Cerebrovascular Disease.	Evaluate the prevalence of OSA in patients with cerebrovascular disease (CVD)	- Systematic review, meta-analysis with meta-regression and subgroup analysis - Level I - IV: systematic review of OSA in CVD patients - DV: Increased risk of OSA in CVD patients	- 37 studies analyzed, ranging from risk factors for OSA, the prevalence of OSA, treatment of OSA with CPAP - Convenience sampling - Setting: China	- Systematic literature search and meta-analysis	- Diagnosis/treatment of OSA is important to prevent CVD - 61.9% prevalence of OSA in CVD patients - Analysis: STATA 11.0	- Limitation: Selection bias may have underestimated the prevalence of OSA in stroke patients; patients with previous diagnosis of OSA or dementia were excluded. - Realistic use
Huhtakangas, J. K. (2018). The evolution of sleep apnea six months after acute ischemic stroke	Investigate the evolution of prevalence, severity, and type of sleep apnea among patients	- Cohort study with control and non-control group - Level IV - IV: sleep study	- 177 patients (98 in thrombolysis group, 79 in non-thrombolysis group)	- Sleep study - Epworth sleepiness scale - Stroke outcome estimated with a	- Sleep apnea prevalence increased from 89.8% to 92.7% within 6 months after stroke	- Limitations: between groups difference on the basis of criteria for thrombolysis, this population may

and thrombolysis. Journal of Clinical Sleep Medicine.	who had ischemic stroke, with or without treatment with thrombolysis after 6 months.	- DV: prevalence of OSA in stroke patients with or without thrombolysis	- Convenience sampling - Setting – stroke unit at Oulu University Hospital	modified Rankin Scale	- Patients without thrombolysis treatment had a six-fold risk for development of OSA 6 months after stroke	represent a healthier population - Realistic use
Losurdo, A. (2018). Dysphagia and obstructive sleep apnea in acute, first-ever, ischemic stroke. Journal of Stroke and Cardiovascular Diseases.	Evaluate the prevalence of OSA and dysphagia in patients with first ever ischemic stroke, investigate clinical correlates between the two conditions	- Cohort study - Level IV - IV: sleep study, dysphagia screening - DV: OSA and dysphagia significant prevalence in ischemic, first-time, stroke patients	- 140 patients - Convenience sample - Stroke unit in Italy	- NIHSS - Dysphagia screening - sleep study	- 51.4% with OSA, & 57.8% with dysphagia - Relationship of OSA & dysphagia was higher than expected based on the prevalence of each condition in acute stroke	- Limitations: limited population of the study (first time ever ischemic stroke) - Realistic use
Subtopic: OSA compliance & management						
Kotzian, S. T. (2019). Proactive telemedicine monitoring of sleep apnea treatment improves adherence in people with stroke: a randomized control trial (HOPES study)	With PAP training strategy during in-hospital rehabilitation stay and telemedicine monitoring after discharge, does CPAP adherence improve	- Randomized control trial - Level II - IV: standard PAP treatment vs telemonitored PAP treatment - DV: improved PAP adherence	- 70 patients - Convenience sampling - Setting: Austria	- Sleep study - Standard care vs telemonitored care	- People with stroke who accept PAP therapy showed improved adherence compared to the control group	- Limitations: varying coaching strategies, the treatment group had higher Epworth Sleepiness Scale scores - Realistic use
Patil, S. P. (2019). Treatment of adult obstructive sleep apnea (OSA) with positive airway pressure (PAP): An American Academy of Sleep Medicine Clinical Practice Guideline.	Establish practice recommendations for PAP treatment of OSA in adults	- Non- experimental, systematic review, evidence-based practice guidelines - Level I - IV: PAP therapy - DV: Improved OSA management	- Setting: United States	- Continuous PAP	- Initiating PAP therapy should be based on a diagnosis of OSA from sleep study - PAP follow-up should happen during therapy initiation and during treatment of OSA.	- Limitations: none identified - Realistic use

Journal of Clinical Sleep Medicine.						
Carlucci, M. (2018). Early telemedicine to promote continuous positive airway pressure adherence. The Journal for Nurse Practitioners	- Implement CPAP adherence practice change project - Determine if telemedicine visits implemented within first week of CPAP use promotes adherence	- Qualitative study - Level V - IV: telemedicine - DV: improved CPAP adherence	- 14 patients met inclusion criteria - Convenience sampling - Setting: Illinois & Missouri	- Adherence report - Telephone talking points	- 71% adherence rate in the telemedicine group - 43% adherent in non-telemedicine group	- Limitations: Small sample size, concern for NP's role could have had unintended influence on patients - Usefulness – despite small sample size, results were positive showing telemedicine helped improve adherence of CPAP use
Colelli, D. R. (2018). Predictors of CPAP adherence following stroke and transient ischemic attack. Sleep Medicine.	Determine CPAP adherence predictors in stroke/TIA patients	- Cohort study, non-randomized - Level IV - IV: CPAP adherence - DV: reasons for poor CPAP adherence	- 313 patients screened for OSA via a sleep study, 88 were diagnosed & prescribed CPAP (46 adherent, 42 non-adherent) - Convenience sampling - Setting: Canada	- In hospital sleep study or home sleep test	- Patients with greater functional status and those not endorsing daytime tiredness demonstrated better CPAP adherence - Analysis: Mann-Whitney U test	- Limitations: Non-randomized study, medication or lifestyle may have affected CPAP adherence, small sample size - Realistic use

Appendix D

Evidence Grid

Article (last name of first author, date)	Screening tools & OSA diagnosis in stroke patients	Treating OSA improves stroke risk factor mgt	OSA & stroke education improves patient knowledge	OSA treatment improves stroke recovery	High prevalence of OSA in stroke patients	OSA compliance & mgt challenges for patients
Amra, 2017	X					
Boulos, 2019	X					
Boulos, 2016	X					
Bravata, 2018				X		
Carlucci, 2018						X
Colelli, 2018						X
Dharmakulaseelan, 2019			X			
Donald, 2018			X			
Dong, 2018					X	X
Gupta, 2018		X				
Holzemer, 2011			X			
Huhtakangas, 2018					X	
Ifergane, 2016	X					
Jehan, 2018		X		X	X	
Katzan, 2016	X					
Kernan, 2014		X		X	X	
King, 2016		X				
Kim, 2016		X				
Kotzian, 2019						X
Losurdo, 2018					X	
Menon, 2017				X		
Mohammad, 2019	X					
Navalkele, 2016	X					
Patil, 2019						X
Ren, 2019				X		X
Schipper, 2017		X				

Schipper, 2016	X				X	
Seiler, 2019					X	
Severine, 2016	X					
Skolarus, 2012	X					X
Zhang, 2019	X					
Zhang, 2017				X		

Appendix E

Theory Diagram – Health Promotion Model

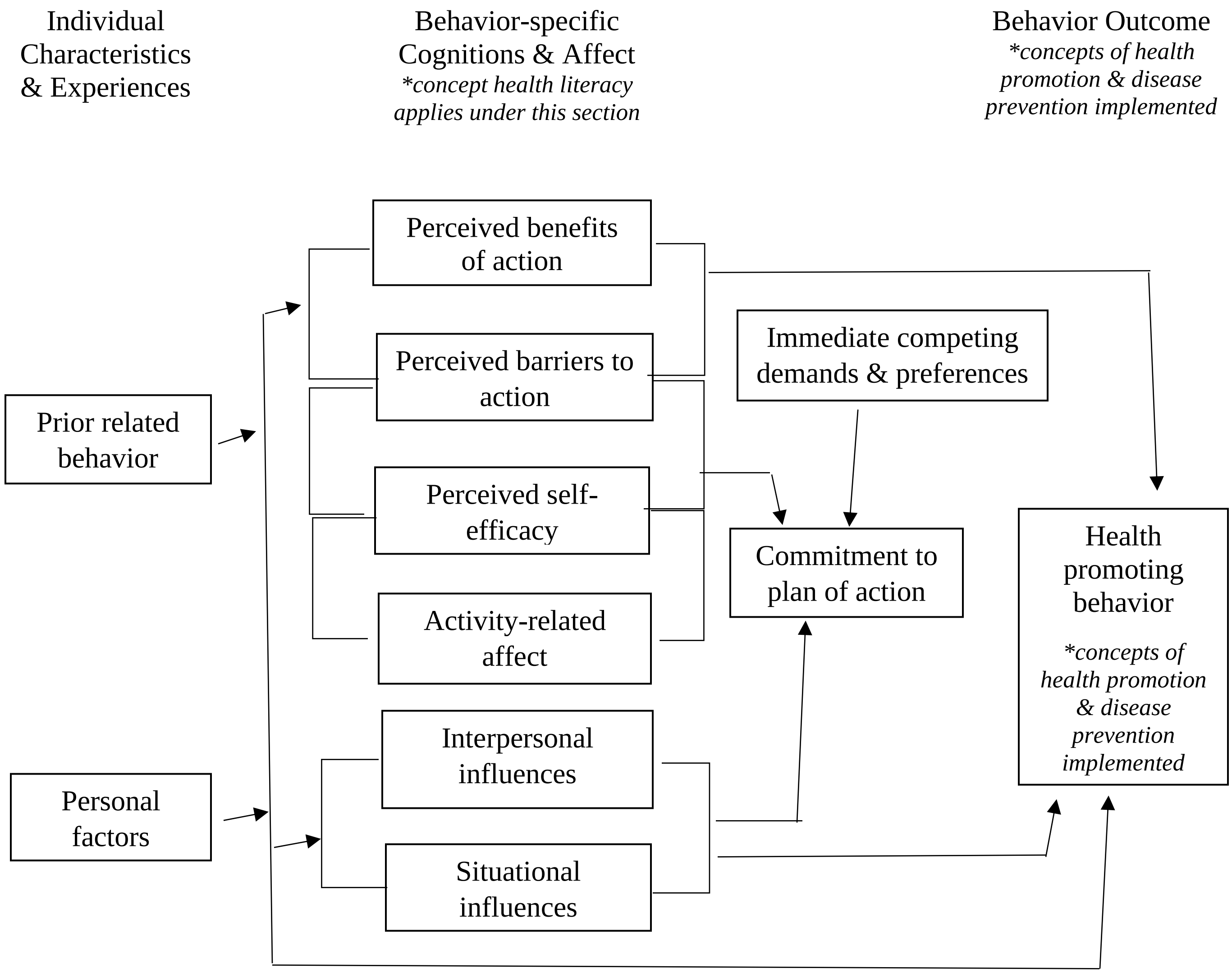


Diagram of the health promotion model, incorporating the concepts of health promotion, disease prevention, and health literacy as related to the inquiry. (Pender et al., 2011).

Appendix F

IRB Approval Letter

WIRB
Global Leader | Proven Expert

June 2, 2020

Tara Nash (Elledge), ANP
****
****
***********, Missouri *****

Dear Ms. Nash (Elledge):

SUBJECT: REGULATORY OPINION: IRB EXEMPTION
Investigator: Tara Elledge, ANP
Protocol Title: Obstructive sleep apnea (OSA) screening via the STOP-Bang questionnaire in radiographically confirmed stroke patients at ********************* from August 2020 to February 2021

This letter is in response to your request for an opinion as to whether the above-mentioned project would constitute human subject research requiring IRB review.

This opinion is based on federal regulation 45 CFR 46 and associated guidance.

Under 45 CFR 46.102(l), the definition of research includes "…a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge. Activities that meet this definition constitute research for purposes of this policy, whether or not they are conducted or supported under a program that is considered research for other purposes. For example, some demonstration and service programs may include research activities."

The Office of Human Research Protection has issued guidance indicating that quality improvement projects do not meet the definition of research. This guidance states:

Question 2: Do the HHS regulations for the protection of human subjects in research (45 CFR part 46) apply to quality improvement activities conducted by one or more institutions whose purposes are limited to: (a) implementing a practice to improve the quality of patient care, and (b) collecting patient or provider data regarding the implementation of the practice for clinical, practical, or administrative purposes?
Answer: No. Such activities do not satisfy the definition of "research" under 45 CFR 46.102(d), which is "…a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge…" Therefore, the HHS regulations for the protection of human subjects do not apply to such quality improvement activities, and there is no requirement under these regulations for such activities to undergo

review by an IRB, or for these activities to be conducted with provider or patient informed consent.

This project does not involve research. This project intends to evaluate adding obstructive sleep apnea screening to discharge procedures for stroke patients. The intent of the project is to improve care at *******************. Therefore, WIRB has determined this project is not research and does not require IRB review.

This determination that this project is not research subject to 45 CFR 46 can apply to multiple sites, but it does not apply to any institution that has an institutional policy of requiring an entity other than WIRB (such as an internal IRB) to make such determinations. WIRB cannot provide a determination that overrides the jurisdiction of a local IRB or other institutional mechanism for making such determinations. You are responsible for ensuring that each site to which this determination applies can and will accept WIRB's determination.

Please note that any future changes to the project may affect its status as research, and you may want to contact WIRB about the effect these changes may have on the status before implementing them. WIRB does not impose an expiration date on its determinations of research.

If you have any questions, or if we can be of further assistance, please contact Kelly FitzGerald, PhD, at 360-252-2578, or e-mail RegulatoryAffairs@wirb.com.

KAF:jfd
Not Research-Quality Improvement Exemption-Elledge (06-02-2020)
cc: Sharon Stawinski, HCA Midwest Health
WIRB Accounting
WIRB Work Order #1-1310662-1

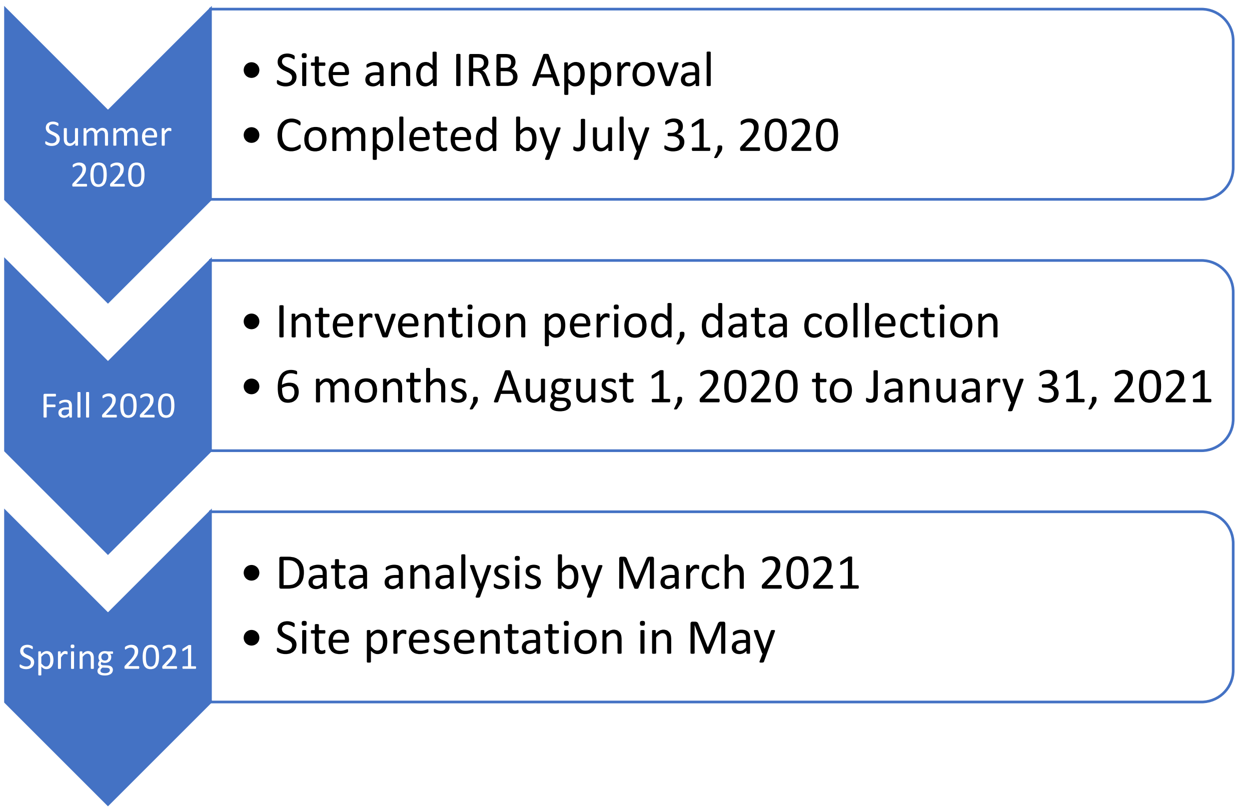
Appendix G

Cost Table for Project

Item	**Item Description**	**Quantity**	**Unit Cost**	**Anticipated Cost**
Print materials	STOP-Bang questionnaire OSA/stroke education handouts/information letter	100 100	\$0.02/sheet \$0.02/sheet	\$2.00 \$2.00
Miscellaneous	Additional office supplies	Various	Various	\$10.00
Student Time	Tara Nash – hours spent preparing, implementing, analyzing data	Total hours varied	Time donated by DNP student	\$0
MD/NP	Additional outpatient providers that may follow up with study participants PSG results/OSA education	Total hours varied	Time graciously donated by providers for DNP project	\$0
Total				\$14.00

Appendix H

Project Timeline Flow Graphic



Appendix I

Information Letter

To Whom It May Concern:

My name is Tara Nash and I am a Doctor of Nursing Practice (DNP) student at the University of Missouri – Kansas City. I am conducting an evidence-based quality improvement (EBQI) project at ***************** focusing on improving stroke risk factor management by screening stroke patients for obstructive sleep apnea (OSA) risk.

For this EBQI project, you will be screened for OSA via the STOP-Bang questionnaire. This questionnaire has eight yes/no questions. S (do you snore loudly?), T (do you often feel tired, fatigued, or sleepy during the daytime?), O (has anyone observed you pause breathing during sleep?), P (do you have or are you being treated for high blood pressure?), B (body mass index greater than 35?), A (age over 50 years old?), N (neck circumference greater than 40 cm?), G (male gender?). Answering yes to three or more questions will prompt a referral for a sleep study, also known as a polysomnography (PSG). Once the sleep study is completed, you will follow up with myself or another provider at Midwest Neurology Physicians. There your sleep study results will be reviewed and if diagnosed with OSA, treatment options will be discussed. If you chose the continuous positive airway pressure (CPAP) option, you will be evaluated again in the outpatient clinic setting in approximately 30 days to ensure your OSA is fully treated. Additionally, demographic data, including age, race, gender, and type of stroke will be collected for data analysis.

Why participate in this project? Once diagnosed with a stroke, the focus shifts to stroke risk factor management. Your providers will look at modifiable stroke risk factors, which include chronic diseases that could affect your future stroke risk and addressing lifestyle modifications that could decrease your stroke risk. By addressing these potential risks, you can improve your health and decrease your risk of future strokes. Current modifiable stroke risk factors addressed at include hypertension, hyperlipidemia (high cholesterol), diabetes, encouraging smoking cessation, and initiation of antiplatelet therapy (starting Aspirin for example). Through this project, screening for OSA risk will be added.

Thank you for participating in this EBQI project.

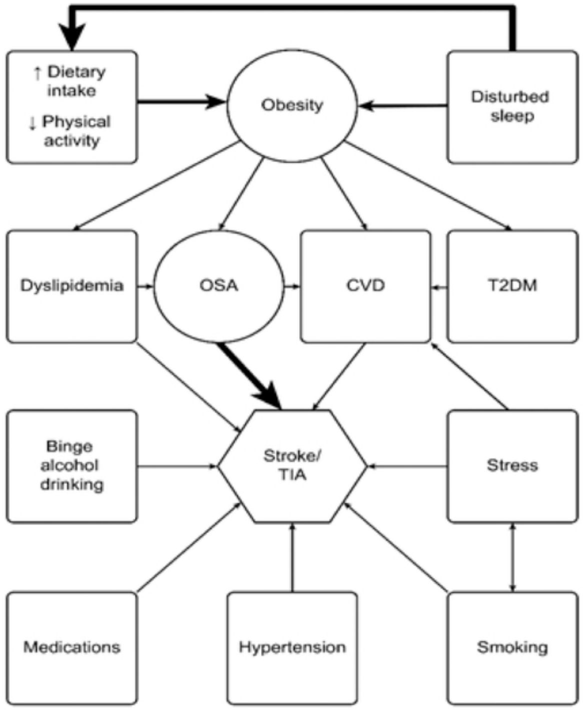
Sincerely,
Tara Nash, DNP student, ANP-C
University of Missouri – Kansas City
Email: tme885@mail.umkc.edu

UMKC
School of Nursing and
Health Studies

Appendix J

Education Materials 1

What are modifiable stroke risk factors? Modifiable stroke risk factors are chronic diseases or lifestyle modifications that can be changed or managed to decrease the risk of stroke. Below is a figure taken from Jehan et al. (2018) that identifies modifiable stroke risk factors.



Why is screening for OSA important in stroke patients? To prevent recurrent stroke, the national guidelines recommend screening stroke patients for OSA risk (Kernan et al., 2014). This recommendation is based on the high prevalence of OSA in stroke patients and the positive research evidence that shows improved outcomes from treating OSA in stroke patients (Kernan et al., 2014).

What is the connection between stroke and OSA? The connection between stroke and OSA is not fully understood within the neurology medical community. It is known that OSA causes oxygen levels to drop and untreated OSA can lead to elevated high blood pressure, both of which can increase the risk of stroke. When low oxygen levels persist, the body releases stress hormones which can increase the blood pressure and lead to fluctuations in heart rate, which also can increase the risk of stroke.

References

Jehan, S., Farag, M., Zizi, F., Pandi-Perumal, S. R., Chung, A., Truong, A., Louis, G. J., Tello, D., & McFarlane, S. I. (2018). Obstructive sleep apnea and stroke. *Sleep Medicine Disorders, 2*(5), 120-125. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6340906/

Kernan, W. N., Ovbiagele, B., Black, H. R., Bravata, D. M., Chimowitz, M. I., Ezekowitz, M. D., Fang, M. C., Fisher, M., Furie, K. L., Heck, D. V., Johnston, S. C., Kasner, S. E., Kittner, S. J., Mitchell, P. H., Rich, M. W., Richardson, D., Schwamm, L. H., & Wilson, J. A. (2014). Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack. *Stroke, 45,* 2160-2236. https://doi.org/10.1161/STR.0000000000000024

Appendix K

STOP-Bang Questionnaire Screening Tool

1. *S* noring
Do you *s*nore loudly (louder than talking or loud enough to be heard through closed doors)?
Yes No

2. *T* ired
Do you often feel *t*ired, fatigued, or sleepy during daytime?
Yes No

3. *O* bserved pauses
Has anyone *o*bserved you stop breathing during your sleep?
Yes No

4. Blood *p* ressure
Do you have or are you being treated for high blood *p*ressure?
Yes No

5. *B* MI
*B*MI more than 35 kg/m2?
Yes No

6. *A*ge
*A*ge over 50 years old?
Yes No

7. *N* eck circumference
*N*eck circumference greater than 40 cm?
Yes No

8. *G* ender
*G*ender male?
Yes No

High risk of OSA: answering yes to three or more items
Low risk of OSA: answering yes to less than three items

Questionnaire reproduced from Chung et al. (2008).

Appendix L

Education Materials 2

Obstructive Sleep Apnea Education

What is Obstructive Sleep Apnea (OSA)?

- It is a common, but serious sleep disorder in which you pause breathing during sleep.
- When you go to sleep, your airway becomes obstructed or blocked from the tissues in the back of your throat relaxing during sleep, limiting the amount of air into your lungs. This can cause you to snore, make choking noises, or gasp for air.
- When you pause breathing, your oxygen level can drop. Over time this can lead to high blood pressure, heart disease, diabetes, depression, and stroke (American Academy of Sleep Medicine [AASM], 2020).

Sleep Study (or polysomnography) Test Results – What's important?

- **Apnea-Hypopnea Index (AHI):** Measurement of complete (apnea) and partial (hypopnea) pauses in breathing per hour during sleep (AASM, 2008). Your sleep study AHI is the number of times you paused breathing PER HOUR during the sleep study. This number should be less than 5. Your number was ________.
- **Oxygen desaturation percentage:** When you pause breathing, your oxygen level drops, also known as oxygen desaturation percentage. This should be greater than or equal to 90%. Your percentage was ________.

Obstructive Sleep Apnea Treatment Options

- **Continuous Positive Airway Pressure (CPAP):** CPAP is a device you wear over your mouth and/or nose during sleep that provides positive airway pressure continuously to keep your airway open. This helps prevent pauses in breathing and prevents oxygen levels from dropping by keeping your airway open. With CPAP, your sleep provider can download data from the machine to monitor your AHI to ensure your OSA is fully treated. Most people can get to an AHI of less than 5 with CPAP treatment.
- **Oral Appliances:** An oral appliance is typically made by a dentist specially trained in sleep medicine. They are similar to sports mouth guards. They are designed to reposition or stabilize the lower jaw, tongue, soft palate, or uvula to help keep the airway open (AASM, 2008).
- **Surgery:** Tissue from the soft palate, uvula, tonsils, adenoids, or tongue are removed or reduced (AASM, 2008). By doing this, the airway is opened up allowing you to breathe easier.

References

American Academy of Sleep Medicine (2020). Sleep apnea overview and facts. http://sleepeducation.org/essentials-in-sleep/sleep-apnea/overview-facts

American Academy of Sleep Medicine (2008). Obstructive sleep apnea. https://aasm.org/resources/factsheets/sleepapnea.pdf

Appendix M

Intervention Flow Diagram

Step 1: Recruitment of Participants

Convenience sample of radiographically positive stroke patients

Step 2: Educate Potential Participants

Provide education on proposed project, OSA screening, stroke risk factor management

Step 3: Provide Information Letter on Improvement Project

Step 4: Intervention

- Administer STOP-Bang questionnaire to participants
- Referral for PSG to qualifying participants
- Clinic visit to review PSG results and review OSA treatment options
- Participants who chose CPAP seen in clinic in approximately 30 days for additional follow up
- CPAP download reviewed for improved AHI

Step 5: Data Analysis and Dissemination

Appendix N

Logic Model

Inputs	Intervention(s) *Activities*	Outputs *Participation*	Outcomes -- Impact *Short*	*Medium*	*Long*
Evidence, sub-topics 1. OSA screening 2. OSA and stroke risk factor management 3. OSA and stroke education 4. OSA and stroke recovery 5. Stroke and OSA prevalence 6. OSA compliance and management **Major Facilitators or Contributors** 1. Neurology team: 4 physicians, 3 nurse practitioners, 2 stroke coordinators 2. Hospital management 3. Nursing staff **Major Barriers or Challenges** 1. Changing the current way practice is provided to stroke patients 2. Patient compliance with recommendations	**The EBP intervention which is supported by the evidence in the Input column** OSA screening of stroke patients via the STOP-Bang questionnaire **Major steps of the intervention** 1. Screen stroke patients for OSA via the STOP-Bang questionnaire 2. Provide education on the importance of OSA evaluation and treatment and explain the link between OSA and stroke 3. Send referral for sleep study 4. Review sleep study results with patient in clinic discussing options to treat OSA. 5. Those treated with CPAP will be followed up within 30 days for a CPAP compliance visit to evaluate if OSA is treated, thus improving their stroke risk factor management	**The participants (subjects)** Adults 18 and older diagnosed with stroke during hospital stay **Site** Local 285-bed hospital **Time Frame** August 1, 2020 to January 31, 2021 **Consent Needed or other** Informational letter provided **Person(s) collecting data** Project leader Possible MD/NP outpatient setting **Others directly involved.** N/A	**Outcome(s) to be measured with reliable measurement tool(s)** 1. Incidence of OSA in stroke patients identified via STOP-Bang questionnaire 2. Prevalence of OSA in stroke patients verified via sleep study 4. OSA treatment compliance via CPAP download 3. Improvement in stroke risk factor management based on OSA treated **Measurement tools** 1. STOP-Bang questionnaire 2. Sleep study results 3. CPAP compliance download **Statistical analysis to be used.** 1. Descriptive statistics 2. Pearson Correlation Test 3. Eta Coefficient Test	**Outcomes to be measured (past DNP student time).** Improvement in stroke risk factor management by addressing all potential stroke risk factors, including OSA.	**Outcomes that are potentials (past DNP student)** Reduction of recurrent stroke and improvement in patient overall health

Rev. 7/09, 1/2015 http://www.uwex.edu/ces/lmcourse/interface/coop_M1_Overview.htmLogic-Model Worksheet content revisions by Lyla Lindholm, Applied to DNP EBP Project. Not to be placed on web for public used. For UMKC DNP coursework

Appendix O

Data Collection Table

	Gender	Age	Race	Stroke Type (ischemic/hemorrhagic)	STOP-Bang score	Referral for PSG needed (yes/no/decline)	Initial AHI	OSA treatment option participant chose	Post CPAP AHI	OSA treated (yes/no)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
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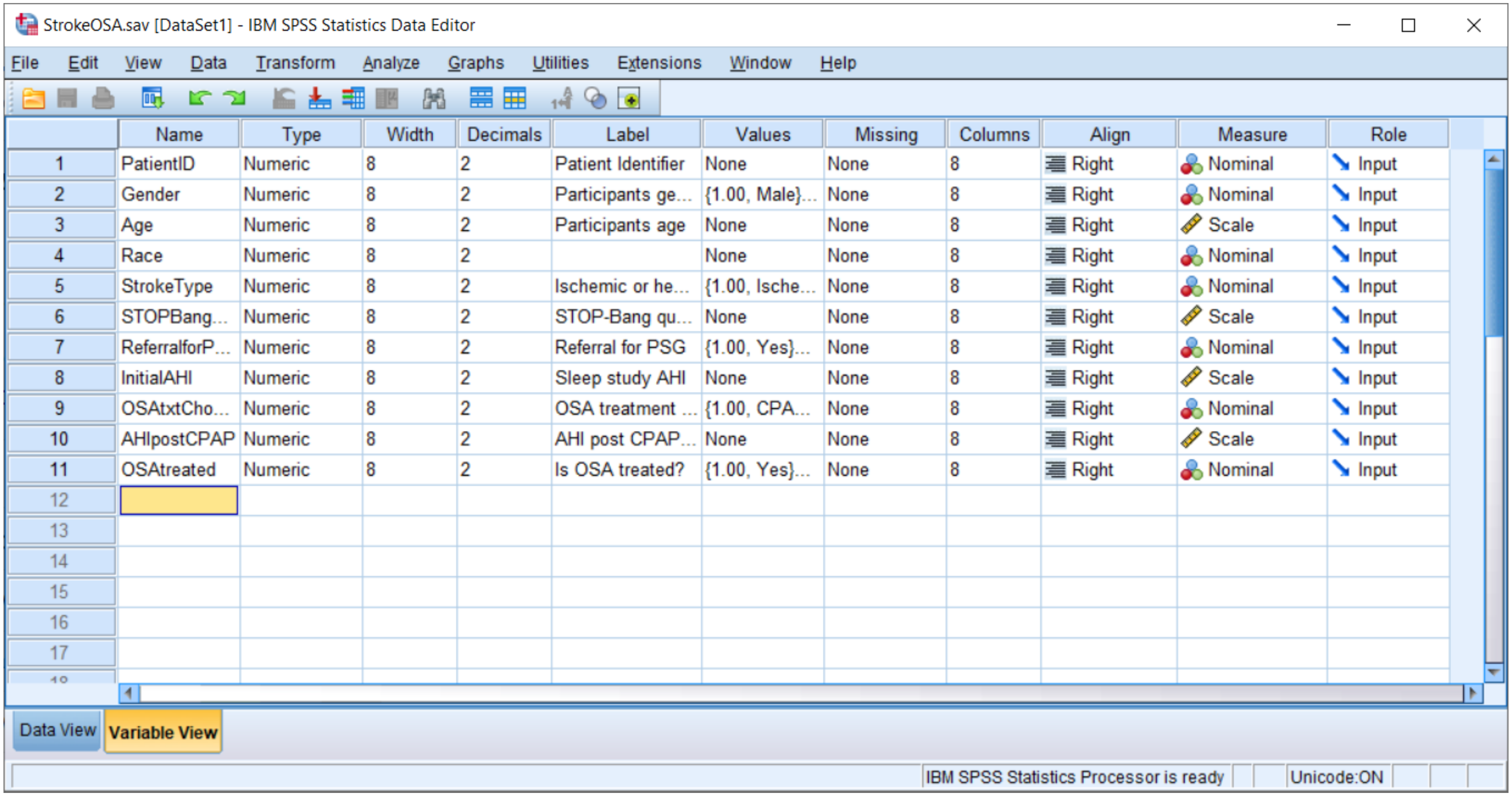
25										

Appendix P

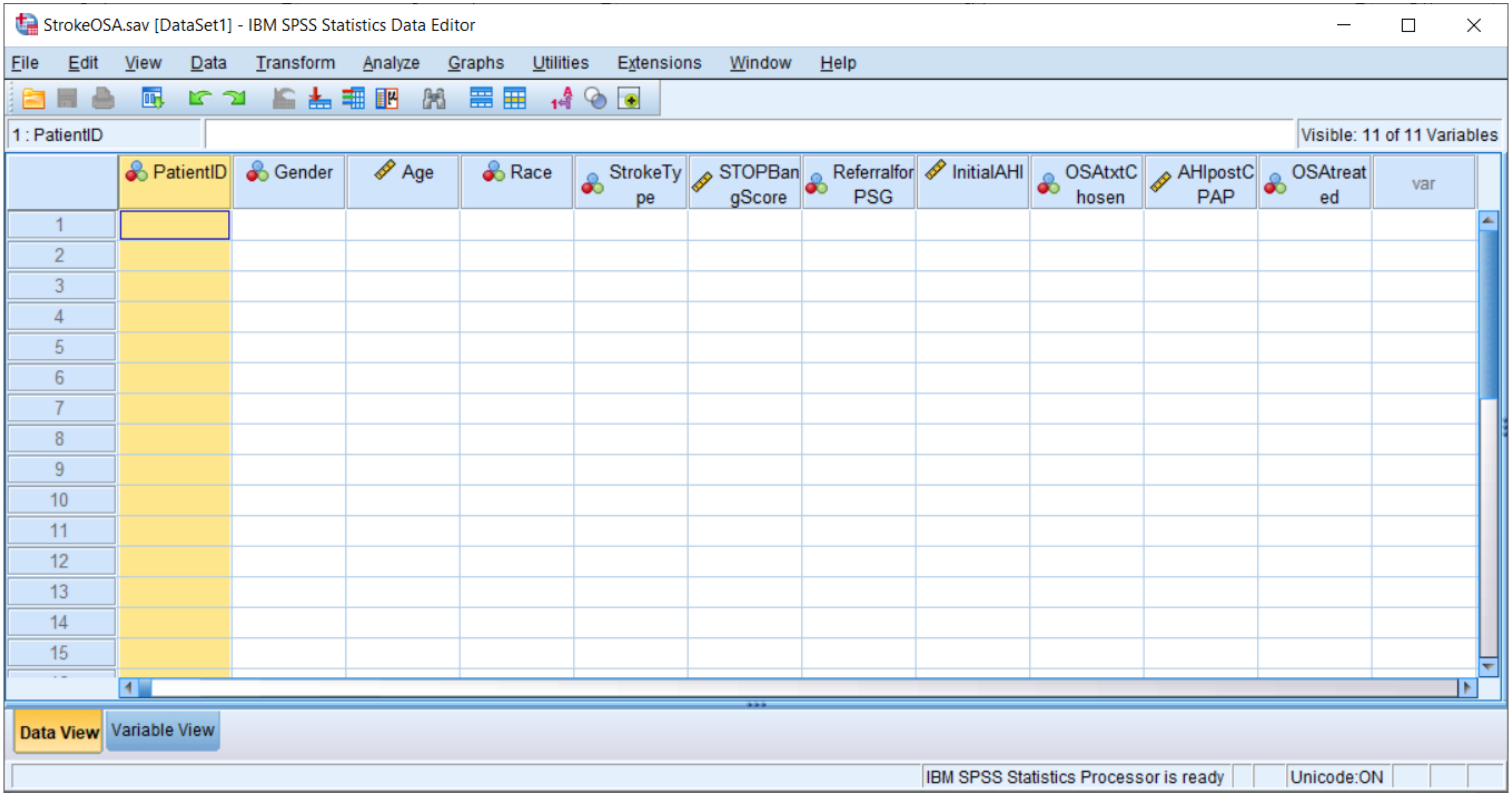
Statistical Analysis SPSS Template – Variable View



	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	PatientID	Numeric	8	2	Patient Identifier	None	None	8	Right	Nominal	Input
2	Gender	Numeric	8	2	Participants ge...	{1.00, Male}...	None	8	Right	Nominal	Input
3	Age	Numeric	8	2	Participants age	None	None	8	Right	Scale	Input
4	Race	Numeric	8	2		None	None	8	Right	Nominal	Input
5	StrokeType	Numeric	8	2	Ischemic or he...	{1.00, Ische...	None	8	Right	Nominal	Input
6	STOPBang...	Numeric	8	2	STOP-Bang qu...	None	None	8	Right	Scale	Input
7	ReferralforP...	Numeric	8	2	Referral for PSG	{1.00, Yes}...	None	8	Right	Nominal	Input
8	InitialAHI	Numeric	8	2	Sleep study AHI	None	None	8	Right	Scale	Input
9	OSAtxtCho...	Numeric	8	2	OSA treatment ...	{1.00, CPA...	None	8	Right	Nominal	Input
10	AHIpostCPAP	Numeric	8	2	AHI post CPAP...	None	None	8	Right	Scale	Input
11	OSAtreated	Numeric	8	2	Is OSA treated?	{1.00, Yes}...	None	8	Right	Nominal	Input
12											
13											
14											
15											
16											
17											

Appendix P

Statistical Analysis SPSS Template – Data View



Appendix Q

Statistical Analysis Tables

Table 1

Participants Demographics

Age (years)	
Mean	71.52; SD 12.55
18-29	0 = 0%
30-39	0 = 0%
40-49	3 = 4.5%
50-59	8 = 11.9%
60-69	19 = 28.4%
70-79	16 = 23.9%
80-89	17 = 25.4%
90 and up	4 = 5.9%
Gender	
Male	31 = 46.3%
Female	36 = 53.7%
Race	
Caucasian	55 = 82.1%
African	7 = 10.4%
Hispanic	1 = 1.5%
Asian	4 = 6%

Stroke Type

Ischemic	62 = 92.5%
Hemorrhagic	5 = 7.5%

STOP-Bang Scores

Greater Than 3 yes answers	46 = 68.7%
Less Than 3 yes answers	21 = 31.3%

PSG Referral Needed Based on STOP-Bang Score

Yes	14 = 20.9%
No	21 = 31.3%
Declined	32 = 47.8%

Appendix R

Table 2

Correlations[a]

		Participants age	STOP Bang questionnaire
Participants age	Pearson Correlation	1	-.066
	Sig. (2-tailed)		.593
STOP Bang questionnaire	Pearson Correlation	-.066	1
	Sig. (2-tailed)	.593	

a. Listwise N=67

Table 3

Directional Measures

			Value
Nominal by Interval	Eta	Referral for PSG Dependent	.543
		STOP Bang questionnaire Dependent	.836

Table 4

Directional Measures

			Value
Nominal by Interval	Eta	Participants gender Dependent	.502
		STOP Bang questionnaire Dependent	.422

Table 5

Directional Measures

			Value
Nominal by Interval	Eta	Participants race Dependent	.359
		STOP Bang questionnaire Dependent	.065

Appendix R

Table 6

Directional Measures

			Value
Nominal by Interval	Eta	Ischemic or hemorrhagic Dependent	.509
		STOP Bang questionnaire Dependent	.303

Appendix S

Faculty Approval Letter

UMKC School of Nursing and Health Studies

June 19, 2020

UMKC DNP Student, Tara Nash (Elledge)

Congratulations. The UMKC Doctor of Nursing Practice (DNP) faculty has approved your DNP project proposal, Identifying Obstructive Sleep Apnea Risk by Utilizing the STOP-Bang Questionnaire in Stroke Patients: A Project Proposal

You may proceed with IRB application

Sincerely,

Lyla Lindholm, DNP, RN, ACNS-BC
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