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Utilization of Educational Module on The Benefits of Cerebral Oximetry to Reduce Postoperative Cognitive Dysfunction in PACU and ICU

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ABSTRACT

Background: Aging adults are part of the largest group of people receiving surgical interventions and at the highest risk for developing postoperative complications and suffer from cognitive decline, including delirium and postoperative cognitive dysfunction (POCD). Currently, there is research suggesting a correlation between regional cerebral oxygen saturation and the incidence of POCD. Further investigation is needed to establish a link between intraoperative cerebral hypoperfusion and POCD and to create recommendations on its use.

Objective: The focus of this systematic review was to evaluate current research on monitoring cerebral regional oxygen desaturation and the occurrence of POCD in patients over 60 years old enduring cardiac and non-cardiac surgical procedures. This project also assessed if an educational module used to educate anesthesia providers on cerebral oximetry and POCD increased cognitive evaluation frequency in the preoperative and postoperative period in patients at increased risk of developing POCD.

Methodology: With the information from the literature review. A pre-test, post-test and educational module was created to assess the knowledge of anesthesia providers.

Results: The pre-test and post-test did not demonstrate a significant shift in knowledge regarding cerebral oximetry use when caring for individuals at increased risk for POCD.

Discussion: These studies in the systematic review contained several limiting factors, including the limited number of randomized, double-blind studies, and the follow-up period to assess patients for cognitive decline varied with each study. The educational module's sample size served as a limitation to the acquired results.

Conclusion: The educational module improved provider knowledge and attitudes in some areas; however, there was no significant change between the pretest and posttest assessment. Further assessments are required in the future to assess for provider knowledge and skills on utilizing the cerebral oximetry device as a tool to help reduce the incidence of POCD.

INTRODUCTION

Description of the Problem

The aging adult is the fastest-growing population segment in the United States, and accounts for 25% to 30% of individuals undergoing surgical procedures.[1] Due to the many physiological changes ensuing with the aging process, these individuals are at an increased risk of experiencing complications associated with surgery and anesthesia. One such difficulty includes the mild neurocognitive disorder referred to as postoperative cognitive dysfunction (POCD).[1] POCD "refers to decrements from baseline in various cognitive functions such as attention, concentration, memory, executive function, verbal fluency, and/or visual-spatial performance." [2] The onset of this illness is often subtle, with the neurocognitive deficits not presenting themselves for several weeks to months following a surgical procedure, and elderly patients (> 60 years old) are increasingly prone to its development.[1] POCD is suggested to occur in "approximately 26% of patients at one week and in 10% to 13% at three months following non-cardiac surgery."[1, 2] However, only the elderly (> 60 years) are at significant risk (13%) for POCD at three months after surgery.[1,2]

POCD is most commonly linked to cardiac procedures and occurs in 10% to 30% of patients evaluated 1 month after cardiac surgery.[2] In the early stages of its discovery, few studies focused on the relationship between POCD and non-cardiac-related procedures. Currently, research suggests POCD at 3 months after non-cardiac surgery has been linked with increased mortality for as many as 8 years following surgery, placing the elderly undergoing various procedures at an increased risk and anesthesia as a contributing factor.[1,3] The frequency at which this illness occurs is rampant, and measures to reduce the occurrence of POCD must be put into place, and education regarding its prevalence must be disseminated to healthcare providers.

Background and Significance

POCD is a complex issue lacking a definitive treatment or cure. As a result, it is associated with long- and short-term physical, emotional, and financial consequences and impairment on quality of life.[4,5] The economic impacts of POCD are staggering, as current estimates suggest caring for patients with POCD costs more than $150 billion a year.[5] The financial expenditures of this illness impact patients, their families, and the healthcare system. A study reviewing the economic burden of postoperative neurocognitive disorders (PND) amongst the United States-based Medicare patients determined PND's presence within 1 year of the surgical procedure was associated with a $17,275 increase in cost.[6] These increasing healthcare costs and associated complications support the urgency to establish a preventative and educational strategy to identify and reduce POCD. A continued rise in the occurrence of POCD will result in an increased financial burden for patients, their families, and the healthcare system.

There is a gap in knowledge regarding POCD as the pathophysiology remains unknown and is multifactorial. The development of POCD has been theorized to be associated with cerebral hypoperfusion, the inflammatory process related to surgery, and general anesthetics.[3] Furthermore, there is no universally accepted diagnostic criteria for POCD, nor is there a standard definition of what symptom characteristics define POCD.[3] It is critical to establish baseline cognitive function before the surgical intervention to accurately identify cognitive decline following surgery and anesthesia.[3] A test of cognitive function should be standardized for a proper assessment to occur; however, a specific test for preoperative and postoperative evaluation of POCD is yet to be established.[3] Knowledge of treatment modalities for this illness is also lacking; currently, there is no definitive cure for POCD, and management focuses on prevention and early identification.[3] Recommendations to reduce POCD associated with surgery and anesthesia aim at maintaining oxygenation and cerebral perfusion.[3]

Systematic Review Rationale

While most studies focus on the association between cardiac surgery and POCD, new research finds a connection between non-cardiac surgery and POCD. POCD after non-cardiac surgery is linked to increased mortality, risk of prematurely leaving the labor market due to an inability to work, a decline in activities of daily living, dependency on social transfer payments, and being discharged to a skilled nursing facility.[4] Several risk factors for POCD have been identified, including older age, lower education level, a history of a previous cerebral vascular accident (CVA) with no residual impairment, and POCD at the time of hospital discharge.[1] Other risk factors include preoperative depression and cognitive decline, postoperative infection, and having a second operation.[3]

Although the pathogenesis of POCD remains predominantly undetermined, several theories as to why this phenomenon occurs have been postulated, and treatment methods have been suggested. Common hypothesis surrounding the development of POCD suggests it may occur due to intraoperative cerebrovascular autoregulation and hypoperfusion, the inflammatory process associated with surgery, and general anesthetics.[3,7] Thus, a multimodal approach is needed to prevent this postoperative complication.

Currently, the neuroinflammatory hypothesis suggests a multidimensional approach for the treatment of POCD.[8] These treatments support the utilization of several pharmacological agents, which are predominantly divided into three classifications; "blocking inflammation by inhibiting inflammatory mediators, preventing the oxidative component of inflammation, protecting neurons during and promoting neuronal health before surgery." [8] Suggested anti-inflammatory agents include COX-2 inhibitors, Minocycline, and Dexamethasone. Anti-oxidative agents include Statins, N-acetylcysteine, and Edaravone, while pro-neuronal agents include Dexmedetomidine, a centrally acting presynaptic α2 adrenergic receptor antagonist used for sedation.[8] Unfortunately, the employment of these agents only show a modest improvement in reducing POCD, thus leaving room for other methods to be implemented to decrease the frequency of POCD.[8]

The hypothesis suggesting intraoperative cerebrovascular autoregulation and hypoperfusion may be a cause of POCD indicates intraoperative measures and devices to mitigate cerebral hypoperfusion may help eliminate a potential cause of POCD. Cerebral oximeters are non-invasive continuous monitoring devices that utilize near-infrared spectroscopy (NIRS) technology to monitor for adequate cerebral oxygenation, and its values represent a balance between oxygen delivery and consumption.[9] Cerebral oximeters consist of a monitor connected to a probe containing a fiberoptic light source and light detectors, and two adhesive pads placed on the patient overlying the frontal lobe.[9] The light emitted from this device can penetrate the skull to reach the underlying cerebral tissue to calculate cerebral oxygenation continuously.[8] The non-invasive nature and ease of use of the cerebral oximeter can help monitor and allow for early intervention in response to intraoperative cerebral hypoperfusion. Therefore, it is proposed to utilize cerebral oximetry and other standard ASA recommended monitors during surgical procedures to assess cerebral hypoperfusion in patients at increased risk for developing POCD to evaluate cerebral perfusion and provide early intervention.

Objectives of the Systematic Review

As the population of individuals over the age of 60 continues to grow exponentially within the United States, healthcare providers must be aware of effective measures to reduce POCD in this vulnerable population. This systematic review aims to evaluate current research on cerebral oximetry monitors and their ability to predict POCD in the elderly population. This systematic review will utilize current and relevant research to answer the PICO question (i.e., patient population, intervention or issue of interest, comparison intervention or group, and outcome) question.[10] The PICO question under investigation is: (P) In elderly patients (> 60 years old) undergoing cardiac and non-cardiac surgery, (I) does monitoring cerebral oximetry, (C) in comparison to utilizing only the American Association of Anesthesia (ASA) standard monitors,

(O) reduce the incidence of postoperative cognitive dysfunction, and does provider education on cerebral oximetry values increase provider assessment for POCD?

METHODOLOGY

Search Strategy and Sources

Three databases were utilized to perform a comprehensive search, including PubMed, Excerpta Medica Database (EMBASE), and Cumulative Index of Nursing and Allied Health Literature (CINAHL) electronic databases. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used to guide the search and develop the systematic review.[11] PubMed yielded 452 articles, EMBASE yielded 778 articles, and CINHAL yielded 380 articles. A total of 1610 articles were discovered upon the initial search. The original PICO question was utilized to create and narrow search terms and keywords, as is shown in Table 1. Once duplicates were removed, 391 articles were left to be appraised for inclusion in the systematic review.

Table 1 Database Search Table

Database	Key concepts/words	Filters applied
PubMed	Cerebral oximetry OR NIRS cerebral oximetry OR cerebral desaturation AND postoperative cognitive dysfunction OR postoperative neurocognitive dysfunction OR age associated cognitive dysfunction OR neurocognitive decline	• Humans • English • Female • Male • Middle Aged: 45-64 years • Aged: 65+ years • 80 and over • 80+ years

Embase	Cerebral oximetry OR NIRS cerebral oximetry OR cerebral desaturation AND postoperative cognitive dysfunction OR postoperative neurocognitive dysfunction OR age associated cognitive dysfunction OR neurocognitive decline	• Middle aged (45-64 years) • Aged (65+ years) • Very elderly (80+ years)
CINAHL	"Cerebral oximetry" OR "NIRS cerebral oximetry" OR "regional cerebral desaturation" AND "postoperative cognitive dysfunction" OR "postoperative neurocognitive dysfunction" OR "Age associated cognitive dysfunction" OR "neurocognitive decline"	Filters • Academic Journals **Age** • Age 65+ years • Aged 80 & over • Middle aged: 45-65 years **Language** • English

Study Selection and Screening of Evidence

The preliminary PICO question was used to further screen articles and determine which would be useful to the systematic review. The remaining articles were imported into Endnote for further screening. In Endnote, the reports were organized into three groups: Relevant, Irrelevant, and Definite. A sum of 391 articles was screened, 46 articles were placed into the definite folder, 325 were placed in the irrelevant folder, and 20 were placed in the relevant folder to be used as background information if needed. The full text was located for 31 of the 46 articles in the definite folder.

Strict inclusion and exclusion criteria were developed to further evaluate the remaining 31 articles in the "definite" folder. Inclusion criteria included the correct population, elderly or geriatric patients undergoing surgery, the use of a cerebral oximetry device to monitor regional cerebral oxygenation, and different study methods, including randomized control trials, prospective, retrospective, and observational research. Exclusion criteria included studies on children, young adults, or reviews where the dominant adult age is less than 60 years old. Further exclusion criteria focused on studies where the cerebral oximeter was utilized to assess another outcome other than a neurocognitive function or did not mention its impact on postoperative cognitive dysfunction. Books, dissertations, and subjects' other humans were also excluded from the systematic review. The inclusion and exclusion criteria are listed in Table 2.0. A PRISMA diagram for the screening process is detailed in Appendix A, Figure 1.0

Table 2 Inclusion and Exclusion Criteria

Inclusion	Exclusion
Population: • Elderly • Geriatric • Non-cardiac and cardiac surgery Intervention • Utilizing the NIRS cerebral oximetry to assess postoperative cognitive disorders/ dysfunction • Different models of the cerebral oximeter Outcomes: • The ability for regional cerebral oximetry to predict POCD • The inability for regional cerebral oximetry to predict POCD Type of study: • Observational studies • prospective/ retrospective studies • Randomized Control Trials • English language • Pilot study • Questionnaires	Population: • Children • Young adults • Middle aged • Patients with a history of neurological and psychiatric disorders Intervention: • Utilizing cerebral oximetry to assess for factors other than neurocognitive function • Articles that do not include the use of cerebral oximetry for postoperative neurocognitive assessment as a possible outcome Outcomes: • Any article that does not include regional cerebral saturation and postoperative neurocognitive Type of study: • Studies not performed on human subjects • Full text unavailable • Books /magazines/ dissertations

Each selected study was evaluated in a systematic method. The Johns Hopkins research evidence appraisal tool was utilized to assess each study's level and quality of evidence.[12] Level of evidence is graded based on the type of analysis conducted and divided into three levels. Level I evidence includes "experimental study, randomized controlled trial (RCT) Systematic review of RCTs, with or without meta-analysis."[12] Level II evidence includes "Quasi-experimental study Systematic review of a combination of RCTs and quasi-experimental, or quasi-experimental studies only, with or without meta-analysis."[12] Level III evidence is defined as "Non-experimental study Systematic review of a combination of RCTs, quasi-experimental and non-experimental studies, or non-experimental studies only, with or without meta-analysis, qualitative study or systematic review with or without a meta-synthesis."[12]

Furthermore, this tool is utilized to determine the quality of the presented evidence. Quality of evidence is divided into three categories High (A), Good (B), or low (C) quality. A high-quality study contains "consistent and generalizable results, preformed with sufficient sample size and adequate control, had a definitive conclusion and supported by scientific evidence.[11] Good quality evidence contains "reasonably consistent results, a sufficient sample size, some control, and fairly definitive conclusions," while Low-level evidence is inconsistent and is unable to provide a conclusion.[12] Based on the Johns Hopkins research evidence appraisal tool, each appraised article was given a level of evidence rating and a grade for the evidence quality. Information obtained and evaluated for each article include: (1) the authors' name and level of evidence, (2) surgery, the number of participants, and age range of the participants, (3) the anesthetic management utilized, (4) the cerebral oximetry used in the study (4) how cerebral desaturation was defined, (5) the intervention is taken in response to the aforementioned cerebral desaturation, and (6) the study's findings and results as can be seen in Table 3.

RESULTS

Study Selection

The preliminary research question yielded 1610 articles; after duplicates from the three databases were removed, 391 articles remained. Ultimately 360 articles were removed from this list once the primary exclusion criteria were put in place, leaving 31 articles to be analyzed. Twenty more articles were further disqualified based on several criteria, as displayed in Figure 1, leaving 10 full-text articles for appraisal. All evidence levels were evaluated for this systematic review, including Level 1 and 2 evidence graded based on the Johns Hopkins research evidence appraisal tool.[12] A total of 5 Level 1, 4 Level II, and 1 Level 3 full-text articles were utilized in this appraisal and evaluated to answer the PICO question, In elderly patients (> 60 years old) undergoing cardiac and non-cardiac surgery, does monitoring cerebral oximetry, in comparison to utilizing only the American Association of Anesthesia (ASA) standard monitors reduce the incidence of postoperative cognitive dysfunction, and does provider education on cerebral oximetry values increase provider assessment for POCD? Appendix B Table 3 provides a summary of all articles included in the systematic review

Study Characteristics

A wide range of study methods were used for this systematic review ranging from randomized controlled trials to observational and prospective studies. In total, these studies evaluated 945 participants with an average age greater than 60 years old. All studies were published between 2006 and 2017 and were published in the English language. These patients underwent various procedures to determine if intraoperative use of the cerebral oximetry monitoring versus the standard monitors used for the specific procedure could reduce the occurrence of POCD. Procedures include coronary artery bypass graft, orthopedic and abdominal surgery, total hip arthroplasty, and spine procedures.[13-22] The anesthetic method for the procedure being evaluated differed amongst the studies. While most participants underwent general anesthesia, in two studies, the patients were exposed either to a mixture of general and regional anesthesia or regional anesthesia alone, and two studies did not specify the type of anesthetic participants received.[13-22]

Definitions and Outcomes

Cerebral oximetry and cardiac procedures

Four studies focused on evaluating the predictability of POCD via monitoring regional cerebral desaturation in patients experiencing cardiac procedures such as carotid endarterectomy and coronary artery bypass graft (CABG). Of these articles, three studies deemed a correlation between cerebral desaturation and the onset of POCD. [13,14,21] These findings further suggested the greater the level of desaturation from baseline, the more likely a patient is to experience cognitive decline.[14] One of the studies found no difference in the cognitive domains in patients monitored for cerebral desaturation while undergoing cardiac procedures.[19]

Cerebral oximetry and non-cardiac surgery

Four studies determined a correlation between cerebral oxygenation values and cognitive dysfunction in evaluating the use of monitoring cerebral desaturation in patients undergoing non-cardiac surgery, such as orthopedic and abdominal procedures.[15-18] It is also suggested that other factors may impact a patient's risk of developing cognitive decline. Several individuals receiving hip surgery displayed hemodynamic insufficiencies, including lower preoperative hematocrit and hemoglobin and arterial SpO_2 values.[15] Furthermore, the severity of the decrease in cerebral oxygenation was associated with the extent of POCD; patients who experienced cerebral desaturation levels below 50% of baseline experienced more severe POCD than those who did not.[17,18] Two studies evaluating patients undergoing non-cardiac surgery does not support using intraoperative cerebral oximetry for these procedures to predict POCD.[20,22]

POCD and Length of Stay

POCD is often linked to a prolonged hospital stay and was discussed in two of the appraised studies with a different consensus.[2] One study observed the incidence of cerebral desaturation in tandem with cognitive decline and prolonged hospital duration.[18] Meanwhile, another article determined there is not a correlation between rSO2 or POCD and hospital stay.[15]

Risk of Bias

Bias should be assessed to ensure the highest quality data is being presented. The Cochrane Handbook Collaboration's Risk of Bias tool was used to evaluate bias in all the studies included in this systematic review appraisal.[23] Several studies ensured a low risk of selection bias by randomly allocating subjects into their groups, performing a double-blind selection process, and having all operations conducted by the same surgery and anesthesia team.[17,19,21] In contrast, others keep their selection bias risk low by utilizing a computer randomization system to generate and conceal the participants.[17,19,21] However, selection bias was a risk for the observational and prospective studies, as it does not involve randomization or blinding process.[14-16] Attrition bias may have occurred in studies as participants could not complete the necessary post-surgical evaluations.[14,17]

DISCUSSION

Summary of Evidence

Ten articles were appraised for this systematic review. Multiple studies were excluded for numerous reasons, including assessing patients outside of the age group of 60 or older and utilizing cerebral desaturation to measure outcomes other than POCD. Table 2 further elaborates on the various inclusion/exclusion criteria used, which were developed to focus on the patient population and outcome being assessed. Different study designs were evaluated, including but not limited to randomized control trials, observational and prospective studies. Of these 10 articles, four were rated as a high-quality level one evidence; one rated as a good quality level one evidence, two were rated as a good quality level one evidence, two were rated as good quality level two evidence, and one was rated as a good quality level three evidence per the Johns Hopkins' appraisal scale.[12] The results of the studies are as follows:

- Three of the four studies focusing on cardiac surgery concluded cognitive dysfunction is associated with cerebral desaturations, and the utilization of the cerebral oximetry may help improve postoperative cognitive function.[13,14,21]
- One article focusing on cardiac procedures determined cerebral oximetry monitoring did not predict a change in cognitive function.[19]
- Four studies evaluating the use of cerebral oximetry and non-cardiac surgery determined a correlation between cerebral oxygenation values and cognitive dysfunction.[15-18]
- Two studies indicate cerebral oximetry does not help predict cognitive dysfunction in non-cardiac surgery.

Limitations of the Systematic Review

There are many limitations to reviewing postoperative cognitive dysfunction as a gold standard for the definition, assessment tools, and treatment of this illness does not exist.[13-22] As a result, findings can vary depending on how POCD is defined and the neurocognitive batteries implemented to assess a patient's mentation in the perioperative period. Of the 10 studies appraised, each study used a different combination of tests to determine cognitive function. Two of the studies utilized the MMSE, which is a poor predictor of cognitive function.[13,18] However, each of the studies identified how POCD was being evaluated and what postoperative values would indicate a finding of POCD.

Other limitations to these studies included how cerebral desaturation was defined, ranging from a rSO_2 decrease > 20% from baseline to rSO_2 reduction below 75% of baseline or below 50 for more than 15 seconds.[15,21] Furthermore, these studies evaluated patients ranging from ASA I-IV, thus creating inconclusiveness regarding the impact of comorbidities on cerebral blood flow and the development of POCD. Additionally, there was heterogeneity in the time intervals used to assess the participants. While each study evaluated patients before surgery for baseline cognitive function assessment, the follow-up evaluations differed significantly. One study only followed patients up to the time of discharge.[21] Five studies evaluated followed up for 6 days to 1 week.[13,15,16,18,22] Three studies evaluated their patients between a period of 1 and 3 months.[14,19,20] Finally, one study followed its patients for the most extended period evaluating them at 1 week, 2 weeks, and 52 weeks.[17]

Recommendations for Future Research

Further research is indicated in the study of POCD to define, diagnose, prevent, cure, or reduce its occurrence. Research on how to reduce the incidence of POCD must focus on being homogenous on the patients, neurocognitive batteries utilized, how cerebral desaturation is defined, and the patients' follow-up assessment period. Additionally, there is a lack of large-scale randomized control trials to evaluate the role of cerebral oximetry and POCD in the patient undergoing non-cardiac surgery. Future research should focus on how to make results more generalizable to elderly patients. POCD is multifactorial; new research must concentrate on all avenues for reducing the incidence of POCD and allow for a multifaceted patient approach to develop.

Neither of the studies focused on the cost associated with POCD. Some studies suggest a link between POCD and hospital length of stay, while others indicate no correlation between the two.[16,18] Improved research on this topic will help further estimate the potential costs of having patients remain in the hospital for an extended period due to POCD, increased medication use in these patients, and the associated costs. Hospital costs must be evaluated as the increased use of cerebral oximetry would create a greater demand for them in the surgical setting. There are currently several different cerebral oximetry devices on the market of varying costs, and the studies appraised for this systematic review utilized multiple different types. Thus, creating an avenue of research to assess if any of these devices are superior.

Conclusion of Literature Review

After a thorough investigation of the current research, evidence shows that the cerebral oximetry monitor can help attenuate the risk of POCD in older patients undergoing cardiac and non-cardiac surgery, including abdominal and orthopedic procedures. Placement of cerebral oximetry electrodes before induction to gather a baseline saturation and maintaining that value within 20% of the initial value can help improve patient outcomes. Educating anesthesia providers on the benefits of this adjunct tool can reduce long-term patient costs and improve patient outcomes.

METHODOLOGY OF QUALITY IMPROVEMENT

Setting

The setting for this project will take place in a 1,013-bed level one trauma hospital with twenty-two operating rooms and a mixture of anesthesia providers. Providers include anesthesiologist, certified registered nurse anesthetist (CRNA), and anesthesiologist assistant (AA) with various experience levels. These providers perform anesthesia for multiple procedures, including orthopedics, vascular, thoracic, and trauma. Patients receiving care in this facility also suffer numerous comorbidities such as congestive heart failure, coronary artery disease, diabetes mellitus, and additional risk factors.

Recruitment and Participants

Recruitment will take place via an email invitation; surveys will be done virtually. An informational letter was sent to all anesthesia personnel in the operating room, inviting them to participate in the project. An anonymous link to the pre-intervention survey was included in the email. Providers completed the pretest assessment survey on their mobile devices or computers via the Qualtrics survey platform. These protective measures ensured the safety of the data.

All participants who met the inclusion criteria were invited to participate in this voluntary educational module. Anesthesia providers working for other companies and other hospital employees were excluded from participation in this educational module. Potential benefits to participants include improved knowledge of using NIRS cerebral oximetry device to monitor for regional cerebral desaturation and reducing the incidence of POCD in patients older than 60 years old. The potential risk of participating in this educational module includes emotional stress or mild physical discomfort from sitting or standing for an extended period.

Intervention and Procedures

POCD is a prevalent issue in the aging population. It needs to be addressed to reduce the physical, emotional, and financial consequences of its occurrence via educating anesthesia providers on anesthetic practice resources available to help reduce its occurrence. Educational intervention is critical to garner participation and support of utilizing cerebral oximetry as an additional monitor to reduce POCD. The academic module cultured participants on the background history, risk factors for developing POCD, theoretical beliefs regarding its occurrence, and current practice measures geared to reduce its prevalence. A voiceover was provided with the module to explain the information and data further. The educational session included reflection questions to help learners assess their knowledge before and after the module and consolidate the knowledge acquired from the presentation.

An email was sent to the anesthesia providers inviting them to participate in this education module. An anonymous link was included in the email, allowing them to access the pretest, learning module, and posttest. The provider could complete these sections on their mobile devices or computers via the Qualtrics survey platform. No personal identifiers were captured, allowing for anonymity. Once the provider clicked on the given link, they were taken directly to the learning module. First, project partakers viewed an introductory letter explaining the procedure for participation, the voluntary nature of the project, contact information to the principal investigator, and consent for participation. Next, they were directed to a pretest questionnaire, followed by a voiceover presentation. Lastly, a posttest was provided.

Protection of Human Subjects

All data were collected anonymously. No identifiable private information was collected as part of the pretest and posttest surveys. Only investigators have access to the completed pretest and posttest surveys. There are no hard copy forms. Data collected from the pretest and posttest surveys will be tabulated anonymously to electronic spreadsheets, which will be maintained on a password-protected laptop computer. These measures further ensured the protection of participant identity.

Data Collection

The primary instruments utilized to collect data for this project include a 3-step process using the Qualtrics data collection system, including a pretest survey, a video-based educational module, and a posttest survey. The collected data will help to identify the anesthesia providers' knowledge of POCD and cerebral oximetry. Once the data is collected, it will be imported into the SPSS statistics software to be analyzed.

Measurement and Analysis

Before and after surveys of staff knowledge on cerebral desaturation and POCD were evaluated. The pretest and posttest included the same questions to directly assess change in knowledge on cerebral oximetry and POCD and the effectiveness of the learning module. Both surveys contained eight multiple-choice questions to evaluate knowledge and two questions to determine the likelihood of using this new information in future practice. The pretest included demographic questions regarding gender, race, age, position, and years of practice.

Data collected from the Qualtrics pretest and posttest questionnaire was exported into SPSS statistics software. This allowed for analysis of each survey and the associated responses. Statistical analysis was conducted to determine if a change in knowledge occurred after viewing the educational module.

RESULTS OF QUALITY IMPROVEMENT

Pretest and Posttest Sample

Upon original access onto Qualtrics, the preintervention survey contained 25 participants. Of these 25, 9 participants did not receive a random ID number and did not answer the demographic questions asked. Six participants who logged onto the survey could not complete the study due to errors with question display and random ID display. After evaluation, the post-intervention survey was also not completed by these 15 individuals. Therefore, the preintervention sample contained 10 participants. The participants varied in gender, age, race, position held, and the number of years in anesthesia practice. Of the pre-intervention participants, female participants dominated and only included one male. A diverse age group completed the educational module, with the largest group of participants ranging between 25-35 years old (*n* = 6); the next largest group were those between 46-55 years of age (*n* = 2). The participants' race varied, with Caucasian individuals serving as the largest group of participants (*n* = 4), followed by Black/African American participants (*n* = 3). CRNAs made the largest group of participants in the educational module (*n* = 9). Years of experience also varied; most participants had between 0-5 years of experience (*n* = 7). The complete demographic breakdown of the preintervention sample is described in Table 4

Eight (*n* = 8) of the original ten participants participated in the educational module and completed the post-test survey. All eight of these participants were CRNAs *(n* = 8, 100%) and included one male (*n* = 1, 12.5%) and seven females (*n* = 7, 87.5%). Age of those who completed the post-intervention varied amongst these individuals. People between the ages of 25-35 dominated at (*n* = 4, 50%) followed by the 46-55 age group (*n* = 2, 25%). The data also represented a range of ethnicities: Hispanic (*n* = 1, 12.5%), Caucasian (*n* = 3, 37.5%), Black or African American (*n* = 2, 25%), Asian (*n* = 0, 0%), Caribbean (*n* = 2, 25%, Other (*n* = 0, 0%). The data also represented people of varying years of experience in anesthesia practice: 0-2 years (*n* = 3, 37.5%), 3-5 years (*n* = 2, 25%), 6-10 years *n* = 1 12.5%), over 10 years (*n* =2, 25%). Table 4 displays the post-intervention demographics.

Table 4 Demographics

Demographic item	**Pre-Intervention Demographics *N* = 10**	**Post-Intervention Demographics *N* = 8**
	Count	Count
	Percent	Percent
Gender		
Male	1	1
Female	10%	12.5%
	9	7
	90%	87.5%
Age (years)		
25-35 = 6	6	4
36-45 = 1	60%	50%
46-55 = 2	1	1
>55 = 1	10%	12.5%
	2	2
	20%	25%
	1	1
	10%	12.5%
Race		
Hispanic	1	1
Caucasian	10%	12.5%
Black or	4	3
African	40%	37.5%
American	3	2
Asian	30%	25%
Caribbean	0	0
Other	0%	0%
	2	2
	20%	25%
	0	0
	0%	0%
Position/ Title		
Anesthesiologist	1	0
(MD)	10%	0%
Certified	9	8
Registered	90%	100%
(CRNA)	0	0
Anesthesiologist	0%	0%
(AA)	0	0
Resident	0%	0%
Years of		
experience	4	3
(years)	40%	37.5%

0-2	3	2
3-5	30%	25%
6-10	1	1
Over 10	10%	12.5%
	2	2
	2%	25%

Pretest Knowledge

The pretest served to gather current knowledge on cerebral oximetry monitoring and its role in monitoring for POCD. Eight people took the pretest and posttest. Table 5 displays the scores for both components and the differences. The pretest showed the participants were knowledgeable on the population who suffered most from POCD and when cerebral oximetry monitoring should occur (*N* = 8, 100). It also demonstrated a decrease of knowledge in several areas' questions regarding the definition of POCD, the utilization of cerebral oximeters, the risk factors for POCD, and when a patient's mental status should be assessed (*n* = 7, 87.5%). The participants scored the least when questioned on a quick assessment tool that can be used to evaluate a patient's mental status (*n* = 5, 62.5%).

Participants were asked to rate their likeliness to pass on information regarding perioperative cerebral oximetry values to the postoperative care provider. In the preintervention stage, the participants answered as follows: Neither likely nor unlikely (*n* = 2, 25%), Somewhat likely (*n* = 4, 50%), and extremely likely (*n* = 2, 25%). Similarly, when evaluated on the likelihood of assessing patients for signs of POCD in the postoperative period, the preintervention results are as follows: Neither likely nor unlikely (*n* = 2, 12.5%), somewhat likely (*n* = 3, 37.5%), Extremely likely (*n* = 2, 25%), Somewhat unlikely (*n* = 1, 12.5%) Extremely unlikely (N=1,12.5%). These results are elaborated in Table 6.

Table 5 Difference in Pre- and Posttest Knowledge

Questions	Pre-test	Post-test	Difference
1. Which of the following statements best describes postoperative cognitive dysfunction (POCD)?	87.5%	100%	+12.5%
2. How are cerebral oximeters utilized in the clinical area?	87.5%	87.5%	0
3. What group of people are most likely to suffer from POCD	100%	100%	0
4. What are the dominant risk factors for developing POCD?	87.5%	87.5%	0
5. Cerebral oximetry values should remain?	75%	62.5%	-12.5%
6. When should a patient's mental status be assessed?	87.5%	87.5%	0
7. When should the use of cerebral oximetry use be considered?	100%	87.5%	-12.5%
8. A quick tool to assess a patient's mental status is by using which of the following test?	62.5%	87.5%	+25%

Table 6 Difference in Pre- and Post-Test Perspective of perioperative cerebral oximetry monitoring reporting

9. How likely are you to ask/ pass in the report about the use of regional oxygen saturation during surgery and changes from baseline values?

	Pretest	Posttest	Difference
Neither likely nor unlikely	25%	12.5%	-12.5%
Somewhat likely	50%	37.5%	-12.5%
Extremely likely	25%	50%	+25%
Somewhat unlikely			
Extremely unlikely			

10. How likely are you to assess for signs of early POCD in the postoperative period?

	Pretest	Posttest	Difference
Neither likely nor unlikely	12.5%	50%	+37.5%
Somewhat likely	37.5%	37.5%	0
Extremely likely	25%	12.5%	-12.5%
Somewhat unlikely	12.5%		N/A
Extremely unlikely	12.5%		N/A

Posttest Knowledge

Table 5 displays the posttest scores. After viewing the narrated educational module, some areas improved while others remained stagnant or decreased. The data shows a 12.5% increase in the participant's ability to define POCD. Many areas showed no change between the pre and post-test results, such as questions regarding the definition of POCD, the utilization of cerebral oximeters, the risk factors for POCD, and when a patient's mental status should be assessed ($n = 8$, 87.5%). There was not a change in the question regarding which group of people are most affected by POCD as both the pretest and posttest showed a 100% pass rate; therefore, all participants answered the question correctly both times. There was an increase (+25%) in participant knowledge on which quick assessment tool should be utilized to assess a patient's mental status. An unfavorable change occurred in two parts of the quiz. The data showed a decline by 12.5% in two questions, including the range the cerebral oximetry values should remain within and when cerebral oximeters should be used.

Table 6 demonstrates the change of perspective regarding the reporting of cerebral oximetry value changes to the postoperative care provider. There was a 25% change in the participants who are extremely likely to pass on intraoperative cerebral oximetry values. There was also a change of (-12.5%) in participants who reported they would neither likely nor unlikely pass this information forward, demonstrating a positive difference and decisiveness. The postintervention results on the likelihood for the anesthesia provider to assess for signs of POCD in the postoperative period showed an improvement in attitude as none of the participants reported they were somewhat or extremely unlikely to do so, unlike the 12.5% reported for both sections in the pre-test. However, results showed a greater percentage (+37.5%) that reported they were neither likely nor unlikely to do so. Whereas no change occurred in those who reported they were somewhat likely to report this information. Consequently, a change of (-12.5%) was reported in those who are extremely likely to assess for signs of POCD

Summary of Data

Overall, a substantial change in knowledge did not occur, as is demonstrated by Table 5. There was an improvement of knowledge on defining POCD in one participant (*n* = 1, 12.5%), and two participants learned the correct tool to use when quickly assessing a patient's mental status (*n* = 2, 25%). The pretest and posttest demonstrated no change in knowledge for 4 of the 8 questions asked to assess knowledge, but it should be noted one of these questions received a 100% past rate in the pretest, thus showing the participants did not change their answer. The post-test results demonstrated a decrease in knowledge in two areas, as demonstrated by two questions receiving a lower posttest score. This change in posttest scores indicates some providers remain unaware cerebral oximetry values should stay within 20% of baseline values as one (*n* = 1, 12.5%) of the participants answered this question incorrectly. Similarly, when asked when cerebral oximetry usage should be considered, one participant changed their answer leading to a decrease in the postintervention values by 12.5%.

A change in attitude towards reporting intraoperative cerebral oximetry changes to the postoperative care provider was also reported as two more participants (*n* = 2, 25%) reported they are extremely likely to transfer this information. However, a greater amount of uncertainty was raised in some participants after the educational module when assessing an anesthesia provider's likelihood of assessing for POCD in the postoperative period (*n* = 3, 37.5%). The number of participants who were "extremely likely" to perform this assessment declined in the postoperative period equating to a change of -12.5%. However, a positive change did occur in this post-assessment as none of the participants reported they were either "somewhat unlikely" or "extremely unlikely" to assess for POCD postoperatively.

DISCUSSION OF QUALITY IMPROVEMENT

Limitations

The sample size of this survey was a significant limitation. This survey was distributed to 40 people via email; however, only 8 completed the pre-intervention and post-intervention surveys. A greater sample size would have strengthened the reliability of the results. Another limitation of this data is all the participants were CRNAs and did not represent the attitudes and knowledge of the various anesthesia providers at this site. The delivery method of this survey may also serve as a limitation, as this required self-direction, and it is possible participants were unable to set a specific time to focus on the information provided. Providing an in-person class would have ensured the participants viewed the narrated educational module and possibly yielded more reliable data.

Future Implications for Advanced Nursing Practice

POCD is a complex problem without a cure. Due to the many unknown factors associated with this illness, measures to reduce its incidence must be implemented. The outcome of this study demonstrates a need for more information on POCD and the tools available to reduce its incidence. The data collected shows educational modules can be an effective method to educate providers and change their attitudes regarding cerebral oximetry and their assessment for POCD.

Conclusion

POCD is a medical dilemma impacting older individuals undergoing anesthesia, and the anesthesia provider must understand and determine methods to reduce its incidence. Early identifiers of those at risk can help providers put pharmacological and nonpharmacologic management techniques in place to improve patient outcomes. As the number of individuals older than 60 years old undergoing anesthesia continue to increase, it is prudent for measures to protect their cognitive function be put in place. Presently, there is no standard of care for those at risk for POCD, and cerebral oximetry monitoring is not an assessment tool for these individuals. Educational interventions can increase provider knowledge on POCD and improve their likelihood of using devices such as cerebral oximeters to help reduce POCD.

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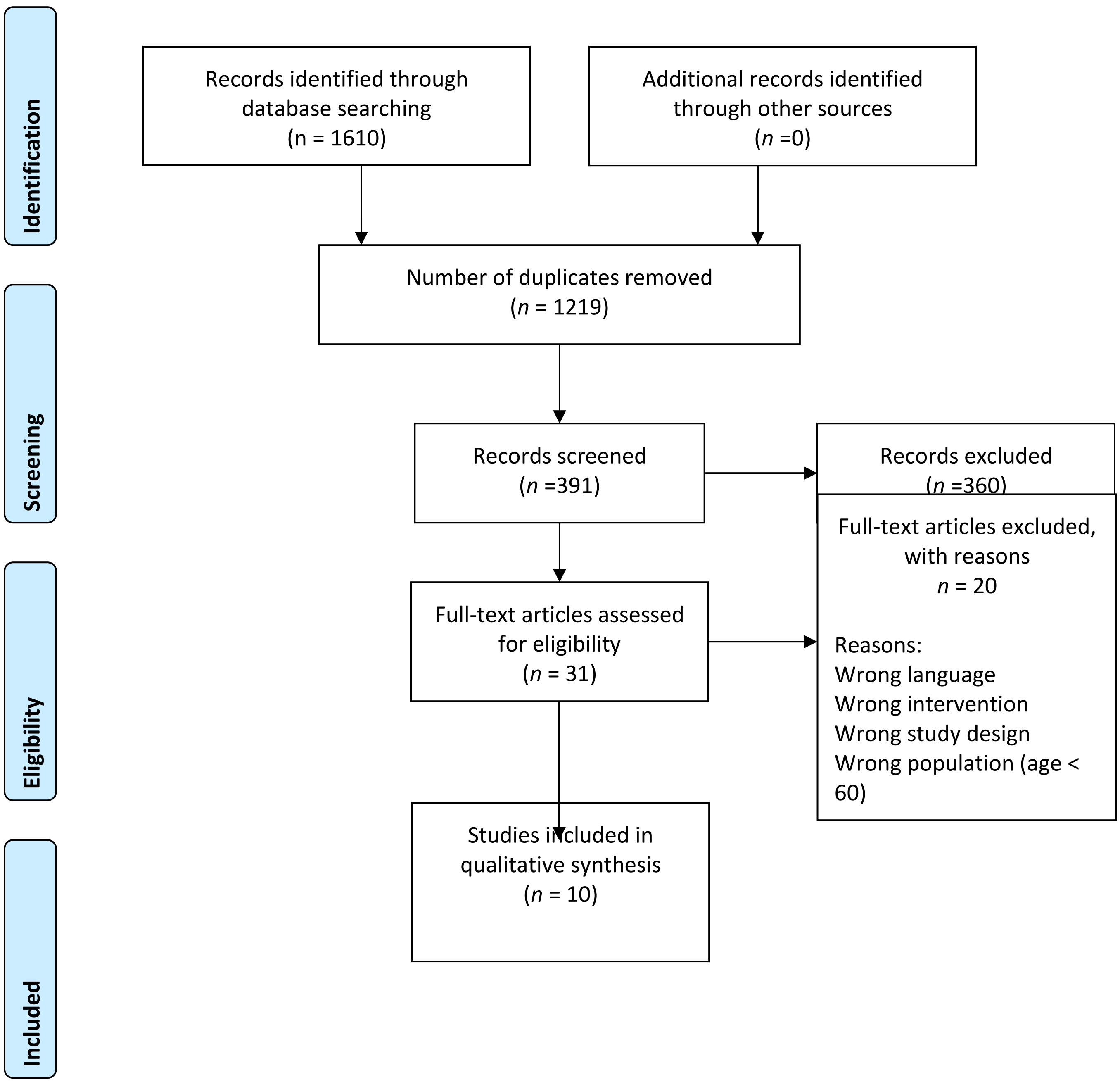
APPENDIX A: PRISMA FLOW DIAGRAM

Figure 1 PRISMA Flow Diagram



APPENDIX B : MATRIX TABLE

Table 3.0 Studies Included in the Appraisal

Author/year/ Level of Evidence	Surgery/number of participants/ Age range	Definition of desaturation	Intervention	Findings
Ballard et al. 2012 Level I Quality A	Elective orthopedic or abdominal surgery. 72 participants > 60 years old (Intervention group *n* = 34 Control *n* = 38)	rSO2 drop more than 15% of baseline value or absolute rSO2< 50%	Bring blood pressure to within 10% of baseline using fluids or inotropes, increasing FIO2 to 50%, etCO2 increased to above 5.5%, consider transfusion if hemoglobin < 9 g.dL [1]	The intervention group experienced a decrease in postoperative cognitive dysfunction as measured by the MMSE, reaction time, and executive function (Trail Making) exams at 1, 12, and 52 weeks
Kara et al. 2015 Level I quality A	CABG 79 participants NIRS (*n* = 43) Age 59.1 ± 9.4 No NIRS (*n* = 36) Age 61.2 ± 10.3	rSO2 decrease > 20% from baseline	Check the patient's head position, increase MAP to > 60mmhg, increase FiO2 and PaCO2, and blood transfusion	MOCA score lower in monitored patients LOS did not change between the two groups
De Tournay-Jetté et al. 2012 Level II quality A	CABG 61 patients mean age of 70.39 +/- 4.69	(1) a decrease in absolute rSO2 values to less than 50%, and (2) a decrease in the relative rSO2 value of 30% compared with the individual baseline value.	Interventions were based on the methodology described by Denault et al. (verify head position, administer vasopressors if hypotension, raise etCO2, raise FIO2, Transfuse PRBC)	Cerebral oxygen desaturation is associated with early and late POCD in elderly patients; the lower the rSO2, there is higher risk for a long-term cognitive decline

Casati et al. 2006 LEVEL II Quality A	General abdominal surgery 60 participants >60 years old	rSO2 decrease <75% of baseline or _80% in case of baseline rSO2 <50%)	Blood transfusion for Blood loss > 20%	Cerebral desaturation can occur in up to one in every four patients. The occurrence of cerebral desaturation is associated with a higher incidence of early postoperative cognitive decline and longer hospital stay.
Ni et al. 2015 Level III Quality B	Elective Total Knee Replacement 78 participants > 65 years old Control group *n* = 20 Study group *n* = 78	ScO_2 less than 50 % or decrease 20 % from baseline	BP elevation and fluid infusion	POCD was found in 15 patients. The ScO2 of patients with POCD was lower than patients without POCD undergoing TKA as indicated by the postoperative MMSE, digital span test, word recognition memory test, Stroop color-word interference (part 3), and verbal fluency test scores after perioperative influential factors were removed
Goettel et al. 2017 Level II Quality B	Major non-cardiac surgery 82 patients ≥65 years of age	Not specified	Not specified	Impairment of intraoperative cerebral blood flow is not an indicator of early POCD, but an association likely exists

Colak et al. 2015 Level I Quality A	Coronary artery bypass grafting (CABG) patients with the use of cardiopulmonary bypass 200 patients Ages from 40-80 INVOS group *n* = 100 Control group *n* = 100	rSO2 below 80% of the baseline value or absolute rSO2 < 50%	Repositioning of the head or bypass cannula to increase cerebral oxygen delivery, increasing FiO2, pCO2, mean arterial pressure, cardiac output or pump flow, and hematocrit) or reducing cerebral oxygen consumption (increasing anesthetic depth and reducing temperature).	Lower incidence of cognitive decline in the INVOS group (INVOS 28 vs. control 52%).
Cowie et al. 2014 Level 1 Quality B	Non-cardiac surgery (total knee or hip arthroplasty or bowel resection surgery) 40 patients >70 years old control group (*n* = 20) or an intervention group (*n* = 20).	rSO2 <75% of baseline)	Avoid obstruction of neck veins, optimize mean arterial pressure, oxygen saturation, end-tidal carbon dioxide, and hemoglobin concentration.	Incidence of cerebral desaturation requires management occurred twice in the intervention group and was not statistically significant. POCD was not determined in either group
Rodgers et al. 2017 Level I Quality A	Cardiac surgery (valve or combined valve surgery and coronary artery bypass grafts using cardiopulmonary bypass mean age 68 years old Intervention: 98 Control: 106	Absolute rSO2 value < 50% or below 70% of baseline	Optimization of cerebral oxygenation used a modified Murkin Protocol (modifying aspects of pump flow, gas exchange, or depth of anesthesia as specified in the algorithm, red cells could be transfused above the 18% hematocrit threshold.)	There is insignificant evidence to support the use of NIRS cerebral oximetry to reduce neurocognitive dysfunction. A patient-specific algorithm aiming to optimize cerebral NIRS values would not benefit organs, such as the heart and kidneys

Papadopoulos et al. 2012 Level II quality B	Hip Arthroplasty 69 patients age 74 +/-13 years	rSO_2 reduction below 75% of baseline or below 50 for more than 15 seconds.	Inspect the ventilator, anesthetic circuit, and position of the head, increase FiO_2, and $PaCO_2$, restore MAP with fluids and vasoconstrictors, transfuse PRBCS	Low preoperative baseline cerebral rSO_2 values are common in elderly patients with hip fractures, correlate with lower preoperative hematocrit, hemoglobin, and arterial SpO_2 values, and are associated with perioperative cognitive dysfunction. There is a positive correlation between rSO_2 and blood transfusion, and a negative correlation with age and cerebral desaturations are associated with prolonged hospital stays.

APPENDIX C: IRB EXEMPTION LETTER

FLORIDA INTERNATIONAL UNIVERSITY

Office of Research Integrity
Research Compliance, MARC 414

Elda Beton

April 7, 2021

"An educational module on the utilization of cerebral oximetry to monitor regional oxygen saturation values to reduce the incidence of postoperative cognitve dysfucntion"

IRB-21-0127 04/07/21
110232

As a requirement of IRB Exemption you are required to:

1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
or
discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at http://research.fiu.edu/irb.

EJ

Memorial Healthcare System
INSTITUTIONAL REVIEW BOARD

3501 Johnson Street, Hollywood, FL 33021
Phone (954) 265-1857 | E-mail: irb@mhs.net
FWA# 00003898 | IRB Registration # 00003075

June 03, 2021

Elda Beton
925 17th ln sw vero beach fl 23962

IRB Project#: MHS.2021.053

Project Title: Utilization of educational module on the benefits of cerebral oximetry to reduce postoperative cognitive dysfunction in PACU and ICU

Submission Type: Non-Human Subject Research Determination (Reference# 007352)

Dear Investigator:

The Memorial Healthcare System Institutional Review Board (IRB) has reviewed the proposed activity referenced above and determined that it does not meet the definition of research with human subjects as outlined in 45 CFR 46.102 or 21 CFR 56.102. Therefore, IRB oversight is not necessary. Please note that you are still required to follow all applicable institutional policies and ethical guidelines. Additional details regarding this determination are provided starting on page 2 of this letter. Please review each page carefully.

Sincerely,

Luke Fiedorowicz, Ph.D.
IRB Director
Memorial Healthcare System

APPENDIX D: QI PROJECT CONSENT

ADULT ONLINE CONSENT TO PARTICIPATE IN A RESEARCH STUDY

"An Educational Module On The Utilization Of Cerebral Oximetry To Monitor Regional Oxygen Saturation Values To Reduce The Incidence Of Postoperative Cognitive Dysfunction (POCD)"

SUMMARY INFORMATION

Things you should know about this study:

- **Purpose:** The purpose of this project is to is to increase the nurses understanding of regional oxygen saturation values and its roll in predicting the incidence of postoperative cognitive dysfunction (POCD), and to identify simple assessment tools to assess for the early onset of POCD.
- **Procedures**: If you choose to participate, you will be asked to complete an emailed pretest/posttest and watch a virtual educational voiceover power point.
- **Duration:** This will take about 20 minutes of your time
- **Risks**: There will be minimal risks involved with this project, as would be expected in any type of educational intervention, which may have included mild emotional stress or mild physical discomfort from sitting on a chair for an extended period of time, for instance.
- **Benefits:** The main benefit to you from this research is: An increase in knowledge of cerebral oximetry values and their indications, and an increase knowledge of POCD. The overall objective of the program is to increase the quality of healthcare delivery and improve the rate of assessment for POCD.
- **Alternatives:** There are no known alternatives available to you other than not taking part in this study.
- **Participation:** Taking part in this research project is voluntary.

Please carefully read the entire document before agreeing to participate.

PURPOSE OF THE PROJECT

You are being asked to be in a quality improvement project. The purpose of this project is to is to increase the nurses understanding of regional oxygen saturation values and its roll in predicting the incidence of postoperative cognitive dysfunction (POCD), and to identify simple assessment tools to assess for the early onset of POCD.

NUMBER OF STUDY PARTICIPANTS

If you decide to be in this study, you will be one of 20 people in this research study.

DURATION OF THE PROJECT

Your participation will require about 20 minutes of your time.

APPENDIX E: QI PROJECT SURVEY

FLORIDA INTERNATIONAL UNIVERSITY

Pretest and Posttest Questionnaire:

Utilization of Educational Module on The Benefits of Cerebral Oximetry to Reduce Postoperative Cognitive Dysfunction (POCD) in PACU and ICU

Introduction

This QI project's primary aim is to improve anesthesia providers' knowledge on the role of cerebral desaturation and POCD.

Please answer the question below to the best of your ability. The questions are meant to assess your knowledge of regional oxygen saturation monitoring (cerebral oximetry) and POCD.

PERSONAL INFORMATION

1. **Gender :** Male Female Other______
2. **What is your current age** 25-35 36-45 46-55 > 55
3. **Choose one or more races you consider yourself to be:**

   Hispanic Caucasian Black or African American Asian

   Caribbean

   Other
4. **Position/Title:** Anesthesiologists (MD) Certified Registered Nurse Anesthetist (CRNA)

   Anesthesiologist Assistant (AA) Resident
5. **How many years have you been an anesthesia provide**?

   Over 10 6-10 years 3-5 years 0-2 years

QUESTIONNAIRE

1. **Which of the following statements best describes postoperative cognitive dysfunction (POCD)?**

A. A change in the mental capacity of an adult to make decisions over time.

B. A change in a patient's mental status occurring in the first 12 hours postoperatively.

C. A decline from baseline in various cognitive functions such as attention, concentration, memory, executive function, or verbal fluency that occur postoperatively and can last from weeks to months

D. A cognitive change that occurs postoperatively in patients who have dementia.

2. How are cerebral oximeters utilized in the clinical area?

A. To monitor for adequate cerebral oxygenation

B. To monitor blood flow to the operating organ

C. To monitor all parts of the brain

D. Cerebral oximeters are utilized to evaluate blood oxygenation content to the entire body

3. What group of people are most likely to suffer from POCD?

A. Kids

B. Older adults > 65 years old

C. Everyone has the same risk of developing POCD

D. POCD does not occur

4. What are the dominant risk factors for developing POCD?

A. Older age, lower education level, a history of a previous cerebral vascular accident (CVA) with no residual impairment

B. Poor nutrition

C. History of anxiety, depression, and dementia

D. None of the above

5. Cerebral oximetry values should remain?

A. Within 20% of baseline

B. Within 15% of baseline

C. Within 50% of baseline

D. Within 70% of baseline

6. **When should a patient's mental status be assessed?**

A. Before surgery

B. In the ICU

C. Before discharge

D. Before, After, and during the surgical stay

7. **When should the use of cerebral oximetry use be considered?**

A. Before orthopedic surgery

B. Before abdominal surgery

C. When a patient is deemed at increased risk for developing POCD based on assessment tools

D. Only during cardiac and major vascular procedures

8. **A quick tool to assess a patient's mental status is by using which of the following test?**

A. Psychometric testing

B. A mini-mental state exam

C. Phonemic fluency test

D. Mental assessments are not required before surgery

9. **How likely are you to ask/ pass in the report about the use of regional oxygen saturation during surgery and changes from baseline values?**

a. Extremely likely

b. Somewhat likely

c. Neither likely nor unlikely

d. Somewhat unlikely

e. Extremely unlikely

10. **How likely are you to assess for signs of early POCD in the postoperative period?**

    A. Extremely likely

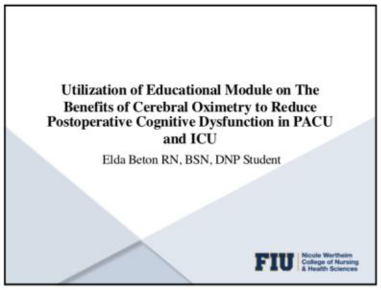
    B. Somewhat likely

    C. Neither likely nor unlikely

    D. Somewhat unlikely

    E. Extremely unlikely

APPENDIX F: EDUCATIONAL MODULE



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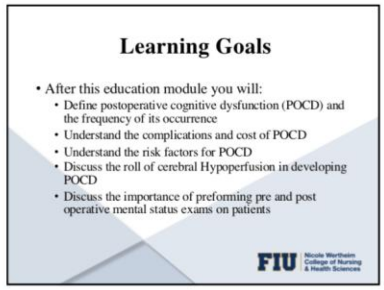

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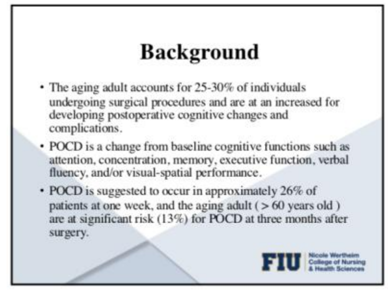

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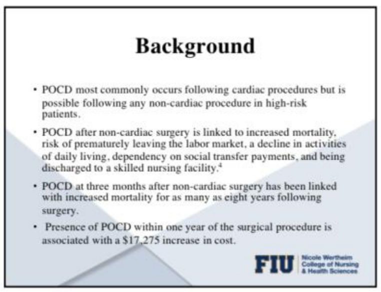

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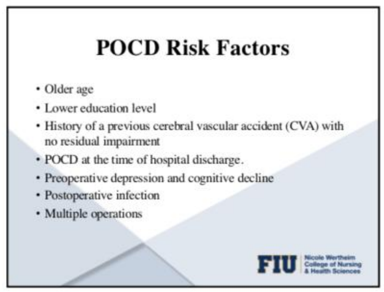

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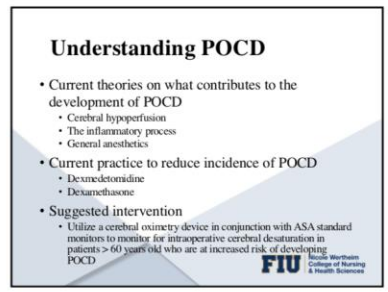

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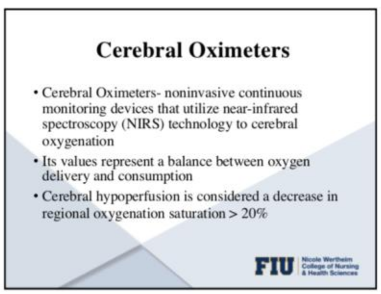

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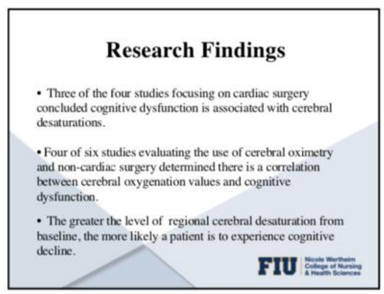

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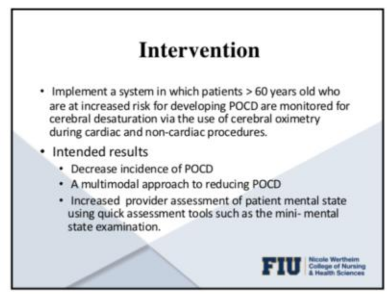

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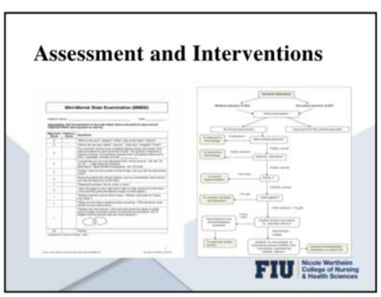

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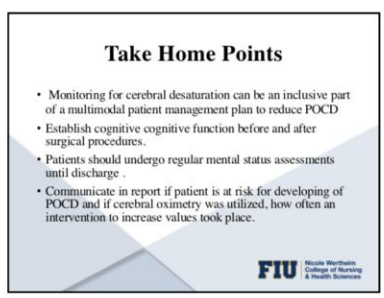

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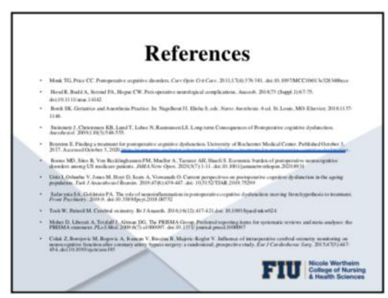

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