Use Versus Non-Use of Dexmedetomidine during Transsphenoidal Tumor Resections

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Abstract

This scholarly project was aimed to determine evidence-based practices for dexmedetomidine use in the anesthetic management of adults undergoing transsphenoidal adenoma resections. A comprehensive literature review on the anesthetic use of dexmedetomidine in neurosurgical patients was performed to establish an evidence-based foundation for the scholarly project. Dexmedetomidine was reported to reduce opioid consumption, provide consistent hemodynamic control, decrease the incidence of uncontrolled intracranial pressure and hematoma, lessen anesthetic agent use, and provide a more rapid recovery from anesthesia by attenuating the effects of surgical stimulation. In addition to a literature review, a retrospective chart review of adults, ages 18-85, who underwent a transsphenoidal resection for adenoma was conducted to provide site-specific data at a large academic medical center. The literature review and site-specific retrospective chart review display conflicting evidence. Thus, additional research perhaps with a prospective pilot study utilizing dexmedetomidine and further site-specific retrospective chart reviews is needed to fully understand the implications of dexmedetomidine for transsphenoidal surgery, not only in terms of hemodynamic stabilization but also in terms of patient care and outcomes.

Keywords: transsphenoidal, neurosurgery, anesthesia, dexmedetomidine, Precedex

Use Versus Non-Use of Dexmedetomidine during Transsphenoidal Resections

At Palmetto Health Richland (PHR), a critical-need change was identified by the author for neurosurgical anesthesia management to improve patient care and outcomes during transsphenoidal tumor resections. Certified Registered Nurse Anesthetists (CRNA) at PHR employ a variety of anesthetic techniques for anesthetic delivery in this complex, neurosurgical patient population undergoing tumor resections. This variation in anesthetic techniques can lead to inconsistent patient care and outcomes. To deliver the best and most consistent care for this patient population, creating an evidence-based approach to anesthesia delivery is a critical next step.

The first step towards implementing this critical-need change is to research what evidence exists for the utilization of dexmedetomidine (Precedex; Hospira, Inc., Lake Forest, IL) for the anesthetic management of adult patients undergoing transsphenoidal tumor resections. Ilhan, Koruk, Serin, Erkutlu, and Oner (2010) stated “that in neuroanesthesia, providers must ensure that the brain is minimally affected by the surgical procedure, without risking autoregulation of cerebral circulation” (p. 61). Additionally, providers must ensure rapid recovery from anesthesia, early neurological assessment, and prevention of the hypertensive responses. Uncontrolled hypertension at the recovery stage is an important issue to reduce the possibility and extent of intracranial hemorrhage. Dexmedetomidine, an alpha-2 agonist, has been reported to decrease the hemodynamic response to tracheal intubation, catecholamine discharge, and surgical stress, thus providing hemodynamic stability and reducing the need for opiates and anesthetic agents (Uyar, Yagmurdur, Fidan, Topkaya, & Basar, 2008; Ilhan, Koruk, Serin, Erkutlu, & Oner, 2010).

The purpose of this scholarly project is to provide both the novice and seasoned anesthetist with the evidence to provide the best progressive care possible. This project aligns with PHR’s value statement for, “excellence” by “pursuing the highest level of service and quality in all that we do” (Palmetto Health, 2016, para. 3). Based on the findings of this scholarly project, the proposed plan is a post-doctoral prospective pilot study utilizing dexmedetomidine in transsphenoidal pituitary resections along with further site-specific retrospective data collection and analysis to evaluate hemodynamic control, opioid and anesthetic agent usage, and length of stay.

Problem Statement

Over the past three years, the neurosurgical department at PHR has dramatically increased the number of neurosurgical procedures performed, including transsphenoidal tumor resections. Currently, there is no medication that is consistently used at PHR to blunt the hemodynamic response(s) to surgical stimulation or that offers the benefits of less opioid usage, enhanced recovery time, reduced length of stay, decreased costs, and improved patient outcomes.

This scholarly project incorporates a literature review of dexmedetomidine, which has the potential to offer both surgical and postsurgical benefits to patient outcomes, and a retrospective chart review of adult patients at PHR who underwent a transsphenoidal approach to tumor resections. Current literature research suggests that dexmedetomidine use improves patient outcomes, decreases opioid consumption and anesthetic agent use, reduces hemodynamic instability, and lessens recovery time. Based on the literature findings, the site-specific chart review focused on the use versus non-use of dexmedetomidine on hemodynamic stability, narcotic consumption, recovery profile including time to extubation, post-anesthesia care unit (PACU) length of stay, and intensive care unit (ICU) length of stay.

Scope of the Project

The primary aim of this scholarly project is to perform a comprehensive literature review on the anesthetic use of dexmedetomidine in neurosurgical patients. The secondary aim is to complete a retrospective chart review of adult (ages 18-85) patients at PHR who have undergone a transsphenoidal resection for tumor between January 1, 2011 and January 25, 2017. The chart review provides site-specific data which will be compared to the current research literature. Exclusion criteria for the retrospective chart review included preoperative admission to ICU, artificial airway upon arrival to the operating room (OR), diagnosis of uncontrolled hypertension, immediate (same day) use of angiotensin converting enzyme inhibitors or angiotensin II receptor blockers, repeated performance of the same procedure for any reason, and intraoperative mortality. The literature review and the retrospective chart review provided data regarding hemodynamic control, intraoperative medications, opioid requirements, end of surgery time, extubation time, PACU stay, and ICU stay. This information will be used to determine if the intraoperative use of dexmedetomidine improves patient outcomes

Synthesis of the Literature

A literature search on dexmedetomidine use in neurosurgical procedures, including transsphenoidal pituitary resections and craniotomies, yielded 22 articles from PubMed and CINAHL (Table 1). The majority of the articles focused on the perioperative use of dexmedetomidine for neurological surgical procedures for the attenuation of detrimental hemodynamic instabilities, opioid-sparing effects, and enhanced recovery profiles. Two articles provided a comprehensive pharmacologic review of dexmedetomidine and its role in anesthesia and critical care.

Pharmacological Properties

Dexmedetomidine is a potent and highly selective alpha-2 adrenoceptor agonist with sympatholytic, sedative, amnestic, and analgesic properties (Afonso & Reis, 2012; Bekker & Sturaitis, 2005). According to Afonso and Reis (2012), dexmedetomine has unique properties that allow for excellent sedation, analgesia, opioid-sparing effects, and minimal respiratory depression. Additionally, it does not affect gastrointestinal motility and has been documented to prevent postoperative nausea, vomiting, and shivering (Afonso & Reis, 2012). Dexmedetomidine does not increase intracranial pressure which offers the benefit of neuroprotection (Afonso & Reis, 2012; Bekker & Sturaitis, 2005). Alpha-2 agonists such as dexmedetomidine also reduce anesthetic requirements and, because of sympatholytic properties, maintain hemodynamic stability during the intraoperative period (Bekker & Sturaitis, 2005).

Intraoperative Concerns

Tumor resection via the transsphenoidal approach causes wide shifts in hemodynamic parameters, commonly resulting in hypertension and tachycardia due to the intense noxious stimuli during various stages of surgery. Gopalakrishna, Dash, Chatterjee, Easwer, and Ganesamoorthi (2015) reported that none of the routinely used anesthetics effectively blunted the undesirable hemodynamic responses and thereby, the need to utilize additional anesthetics or analgesics is commonplace. In their prospective, randomized control study, Gopalakrishna et al. (2015) demonstrated that a dexmedetomidine infusion during transsphenoidal tumor resections helped to maintain hemodynamics (mean arterial pressure [MAP], heart rate [HR]) during the intraoperative and immediate postoperative periods, decreased intraoperative anesthetics, and decreased emergence and extubation times.

In 2005, Bekker and Sturaitis demonstrated that continuous dexmedetomidine infusion improved perioperative blood pressure control without significantly affecting heart rate and improved hemodynamic stability in the PACU, shortening length of stay. Bekker et al. (2008), reported that perioperative hypertension in neurosurgical patients is associated with intracranial hemorrhage and prolonged hospital stay. In this situation, many anesthetists may opt to control intraoperative hemodynamics with traditional anti-hypertensive drugs, such as beta blockers, calcium channel blockers, or vasodilators. Labetalol is commonly used to treat episodes of hypertension but may not be desirable in certain patient populations due to its low potency, slow onset, and unpredictability in dose requirements (Bekker et al., 2008). Esmolol is only mildly effective in treating postoperative hypertension, and its use is complicated by bradycardia and conduction delays. Nicardipine is more effective than esmolol in controlling intraoperative hypertension, but it causes dose-dependent cerebral vasodilation, inhibition of autoregulation, and frequent hypotension. Hydralazine may increase intracranial pressure by as much as 100% and is rarely used in neurosurgical patients (Bekker et al., 2008). It is imperative to control intraoperative hypertensive episodes related to noxious stimuli and prevent early postoperative hypertension, as this may lead to impairment of autoregulation in the tumor resection bed and may be associated with intracranial hemorrhage, vasogenic edema (Rajan et al., 2016), and intracranial hematomas (Yun et al., 2016). A prospective, randomized study conducted by Yun et al. (2016), found that an intraoperative bolus of dexmedetomidine served as a useful adjuvant to control emergence hypertension and reduce postsurgical pain although transient intraoperative hypertension was noted.

In Tanskanen, Kytta, Randell, and Aantaa (2006), dexmedetomidine attenuated the hemodynamic responses to intubation and emergence from anesthesia, increased cardiovascular stability, and offered faster extubation. Turan, Ozgultekin, Turan, Dincer, and Yuksel (2008) found that dexmedetomidine 0.5 mcg/kg administered 5 minutes before the end of surgery stabilized hemodynamics, allowed for easy extubation, and provided for a more comfortable recovery and early neurological examination after intracranial surgery. A randomized, double-blind study conducted in South Korea suggested that a preanesthetic dexmedetomidine single infusion of 1 mcg/kg is a good anesthetic adjuvant method for general anesthesia that can attenuate the hemodynamic response to tracheal intubation and has the advantage of less anesthetic consumption without changing the recovery profile (Shin et al., 2013). In 2016, Yun et al. concurred that controlled and rapid emergence and recovery from anesthesia are important for early neurological assessment and neurological status monitoring, as postoperative consciousness is the best clinical sign of complications, such as intracranial bleeding, seizure, and increased intracranial pressure.

Soliman, Hassan, Rashwan, and Omar (2011) noted that a continuous intraoperative infusion of dexmedetomidine during craniotomy for supratentorial tumors under general anesthesia maintained hemodynamic stability, reduced sevoflurane and fentanyl requirements, decreased intracranial pressure, and significantly improved outcomes. Another study found that dexmedetomidine decreased propofol and fentanyl use, decreased blood loss, stabilized hemodynamics, and increased surgeon satisfaction (Salimi et al., 2014). Peng, Wu, Liu, and Ji (2014) conducted a meta-analysis to collect evidence on the efficacy and safety of dexmedetomidine as an anesthetic adjuvant for patients undergoing intracranial surgery. The authors agree that dexmedetomidine is a safe and efficacious adjuvant to anesthesia, noting improved hemodynamic control, decreased hemodynamic responses, less intraoperative opioid consumption, and attenuated emergence from anesthesia (Peng, Wu, Liu, & Ji, 2014).

Narcotic-Sparing Effects

Peng, Jin, Liu, and Ji (2015) found that an intraoperative dexmedetomidine infusion of 0.5 mcg/kg per hour was effective for reducing postcraniotomy pain and analgesic consumption. Song et al. (2016) also demonstrated via randomized control trial, that an intraoperative infusion of dexmedetomidine had an opioid-sparing effect after craniotomy. Patients who received intraoperative dexmedetomidine experienced greater analgesia and less postoperative agitation (Song et al., 2016). The results of these studies suggest that an intraoperative dexmedetomidine infusion can prevent hyperalgesia and decrease narcotic consumption, leading to less postoperative agitation and pain.

Hofer, Sprung, Sarr, and Wedel (2005) described narcotic management substituting dexmedetomidine for opiate use in patients with extreme obesity and observed that the narcotic-sparing effects of dexmedetomidine were evident both intraoperatively and postoperatively. A prospective, randomized, double-blind study conducted by Gurbet et al. (2006) assessed the intraoperative infusion of dexmedetomidine during abdominal hysterectomy and also noted reduced postoperative morphine requirements without affecting time to extubation. A meta-analysis conducted by Schnabel, Meyer-Friessem, Reichl, Zahn, and Pogatzki-Zahn (2013) found that dexmedetomidine reduced hyperalgesia, decreased postoperative pain intensity, and had an opioid-sparing effect compared to placebo in patients undergoing surgery. Srivastava et al. (2014) conducted a prospective, randomized control study based on dexmedetomidine use for sedation in ICU patients and found that postoperative fentanyl requirements were reduced. Although Hofer et al. (2005), Gurbet et al. (2006), Schnabel et al. (2013), and Srivastava et al. (2014), do not describe the use of dexmedetomidine during neurosurgery, the results suggest that the intraoperative use of dexmedetomidine does produce narcotic-sparing effects.

Length of Stay and Hospital Costs

Retrospective quality improvement research conducted by Patanwala and Erstad (2016) compared total hospital costs and length of stay of critically ill patients who received dexmedetomidine versus propofol for ICU sedation. Patients who received dexmedetomidine experienced shorter time to extubation, decreased length of ICU stay, and less delirium. However, despite these findings, the authors were not able to show any advantage of dexmedetomidine use when compared to propofol use regarding hospital costs and ICU or hospital length of stay (Patanwala & Erstad, 2016).

While Patanwal and Erstad (2016) found no effect in terms of length of stay and costs, Yun et al. (2016) found a delay in time to extubation, delay in recovery, and delay in PACU discharge. In this study, patients received a bolus dose of dexmedetomidine beginning one hour before the end of anesthesia and followed with an infusion of dexmedetomidine.

Other studies noted that intraoperative dexmedetomidine attenuated the emergence from anesthesia (Brady, 2010; Gopalakrishna et al., 2015; Peng et al., 2014), allowed for easier and faster extubation (Gopalakrishna et al., 2015; Tanskanen et al., 2006; Turan et al., 2008), and shortened PACU stay (Bekker & Sturaitis, 2015). However, current research is unclear as to why this phenomenon occurs. Possible explanations include less volatile agent used, along with decreased dosage of propofol and limited narcotic use.

Drug and hospital costs can vary significantly among organizations. Therefore, a cost analysis of dexmedetomidine use - including OR time, anesthesia time, and ICU length of stay is warranted at sites considering the use of this medication. Once the cost analysis is complete, the risks and benefits of utilizing dexmedetomidine must be weighed when choosing whether to incorporate dexmedetomidine into the anesthetic plan.

Literature Review Implications

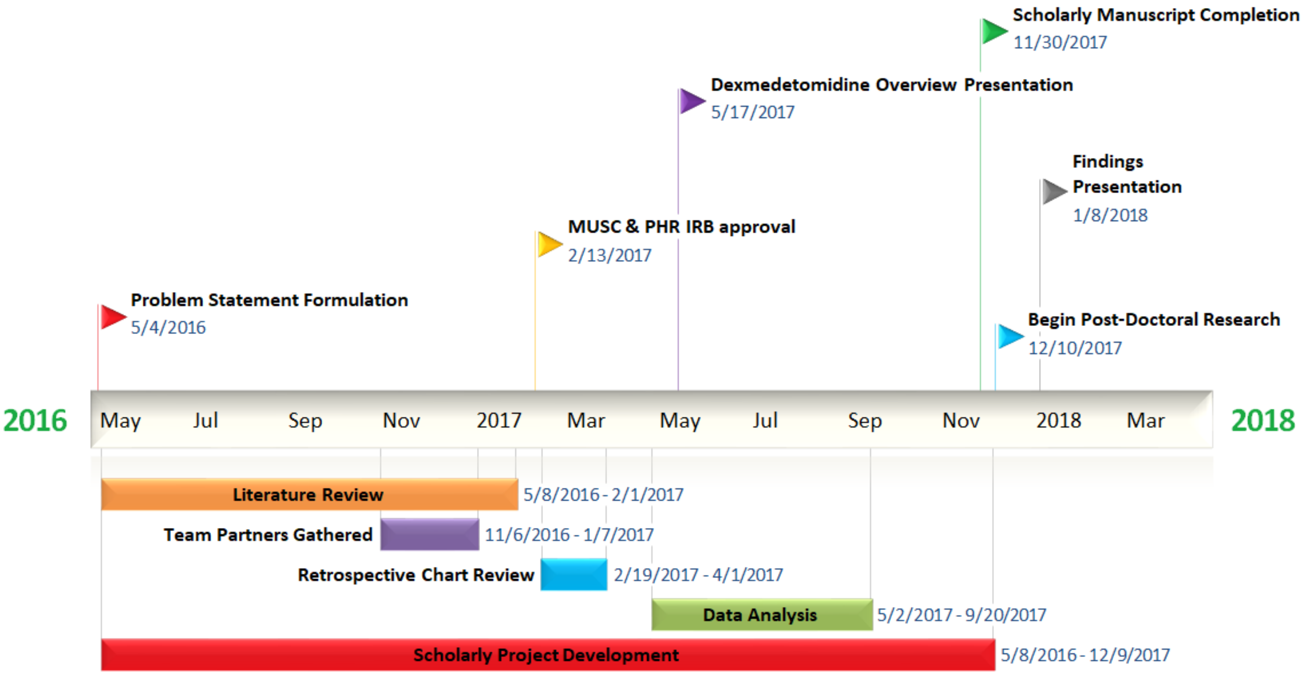
Based on the literature, the intraoperative use of dexmedetomidine during intracranial surgical procedures has the potential to offer improved outcomes compared to the non-use of dexmedetomidine. Dexmedetomidine is reported to reduce opioid consumption, provide consistent hemodynamic control, decrease the incidence of uncontrolled intracranial pressure and hematoma, lessen anesthetic agent use, and provide a more rapid recovery from anesthesia by attenuating the effects of surgical stimulation.

These findings provide evidence for the use of dexmedetomidine to improve patient outcomes. Additional investigation is needed to fully understand the significance of using dexmedetomidine for transsphenoidal surgery, not only in terms of anesthetic implications, but also in terms of patient quality, care, and outcomes.

Theoretical Framework

The Star Model of Knowledge Transformation (Figure 1) describes the cycles, nature, and characteristics of knowledge that are utilized in various aspects of evidence-based practice (Stevens, 2012). The Star Model organizes both old and new concepts of improving care as a whole and provides a framework to organize evidence-based practice processes and approaches. It is a simple, parsimonious depiction of the relationships between various stages of knowledge transformation, as newly discovered knowledge is moved into practice (Stevens, 2012). Schaffer, Sandau, and Diedrick (2013) acknowledged that this model addresses both translation and implementation aspects of the evidence-based practice process. The five Star Model steps are (a) discovery of new knowledge, (b) summary of the evidence following a rigorous review process, (c) translation of the evidence for clinical practice, (d) integration of the recommended change into practice, and (e) evaluation of the impact of the practice change for its contribution to quality improvement in health care (Schaffer et al., 2013). An adaptation of Stevens' (2012) Star Model of Knowledge Transformation guided the literature review and retrospective chart review on the use versus non-use of dexmedetomidine in adult patients undergoing transsphenoidal pituitary resections regarding hemodynamic control, total opioid use, extubation profile, and length of stay.

Project Timeline



Milestones for this scholarly project are as follows:

- Project development
- Selection of team partners
- Literature review
- Institutional Review Board (IRB) application to the Medical University of South Carolina (MUSC) and Palmetto Health Richland (PHR)

- IRB approvals from MUSC and PHR
- Data collection (site-specific retrospective chart reviews)
- Data analysis
- Recommendations from literature review and retrospective chart reviews
- Final written paper
- Presentation of results to stakeholders

Measureable Outcomes Objectives

Objective. To identify best practices for the intraoperative use of dexmedetomidine in adult patients undergoing tumor resections via the transsphenoidal approach.

Rationale. The number of neurosurgical procedures being performed at PHR on a daily basis has increased exponentially. The new group of neurosurgeons expects the anesthesia department to provide the best, evidence-based care possible for their patients. Based on current research, the intraoperative use of dexmedetomidine has the potential to offer intraoperative benefits, including hemodynamic control, less narcotic and anesthetic agent use, and less time spent in the recovery period.

Formative objectives for this scholarly project.

- By February 1, 2017, a literature review on the effects of dexmedetomidine will be completed.
- By February 13, 2017, IRB approval will be obtained from both MUSC and PHR.
- By April 1, 2017, the retrospective chart review will be completed.
- By May 17, 2017, a brief overview of the perioperative use of dexmedetomidine will be presented to CRNAs and student nurse anesthetists (SRNA) at PHR to increase dexmedetomidine awareness.

- By September 30, 2017, the site-specific retrospective chart data analysis will be completed.
- By November 30, 2017, the final written scholarly project manuscript will be completed.
- December 10, 2017, begin post-doctoral research on dexmedetomidine use during transsphenoidal surgery.
- January 8, 2018, scholarly project findings will be presented to the anesthesia care team (ACT) at PHR.

Summative objectives for this scholarly project.

- Primary – Analysis of literature review and site-specific retrospective chart review on the use and non-use of dexmedetomidine on hemodynamics, narcotic use, extubation profile, and recovery and intensive care unit length of stay to reduce or eliminate the gap between the current state of practice and evidence-based practice by September 20, 2017.
- Secondary – Post-doctoral research into dexmedetomidine use in adults undergoing transsphenoidal approach to tumor resection to begin December 10, 2017. The additional research will include further data collection and analysis from site-specific retrospective chart reviews and potentially a prospective pilot study on the use of dexmedetomidine in transsphenoidal surgery.

Leadership and Teamwork

Change Strategy

To ensure the successful creation of change for the intraoperative management and care of patients undergoing a transsphenoidal approach to tumor resection, interventions are outlined through a logic model guided by Lippitt, Watson, and Westley's (1958) theory. This seven-step model of change involves (a) diagnosing the problem, (b) assessing the motivation and capacity for change, (c) assessing the resources and motivation of the change agent, (d) developing action plans and establishing strategies, (e) identifying the roles of the change agent, (f) maintaining the change, and (g) the slow termination of the change agent (Mitchell, 2013; Stichler, 2011).

The critical elements to ensure lasting change for this project have been identified as (a) creating successful change by adapting Lippitt, Watson, and Westley's change theory; (b) establishing change sponsors, agents, targets, and advocates; (c) assembling these individuals into a successful, stress tolerant team to assist in the guideline implementation; (d) aligning the change project with the cultural values of PHR; and (e) identifying and overcoming barriers to the change.

Project Logic Model

A logic model (Figure 2) was selected as a powerful, yet simplistic visualization to bring lasting practice change with clearly defined goals. Logic models offer a framework to promote reflection and can be a useful tool in defining a study's inclusion and exclusion criteria, guiding a literature search strategy, identifying relevant outcomes, identifying mediating and moderating factors, and communicating review findings (Kneale, Thomas, & Harris, 2015). Logic models also support design, planning, communication, evaluation, and learning via graphic illustrations (Knowlton & Phillips, 2012). For this scholarly project the logic model inputs include research, ACT and partners, materials, and medication needed. The outputs consist of the literature search and retrospective chart review, ACT education and buy-in, and maintaining adequate levels of materials, such as intravenous tubing and pumps, and ensuring a steady dexmedetomidine supply. The logic model inputs along with outputs are combined in order to formulate short, intermediate, and long-term outcomes. The ultimate targeted impact for this scholarly project is improved outcomes for neurosurgical patients.

The situation or problem was identified as a critical-need change in the anesthetic management of neurosurgical patients (based on the literature review and retrospective chart review) as evidenced by the lack of evidence-based practices for patients undergoing transsphenoidal tumor resections. Implementing change by increasing the awareness of dexmetomidine for this surgical procedure will provide the foundation for future resarch into evidence-based practices for intracranial procedures via the transsphenoidal approach to tumor resections. Without research into evidence-based practices to care for this population, patients have the potential to be exposed to a multitude of different agents, which may cause detrimental hemodynamic changes, increased narcotic usage, and prolonged recovery time. Additionally, non-evidence-based approaches to anesthetic management of transsphenoidal tumor resections have the potential to increase OR time, lengthen patient recovery time, and delay the return to neurological baseline. Essentially, not using the evidence, or not having enough evidence, can lead to less desirable patient outcomes.

The inputs for the logic model are aligned with Lippit, Watson, and Westley’s (1958) assessment of the motivation and capacity for change and assessment of motivation and resources of the change agent. The anesthesia department at PHR is currently witnessing an exponential increase in the number of transsphenoidal procedures being performed with a new neurosurgical group. Many of the CRNAs are uncomfortable providing anesthesia for these complex cases without further education has provided motivation and capacity for change. Inputs also include involvement of essesntial team members and management of materials.

The outputs illustrated in the logic model are depicted by action plans and strategy development. Research on best practices has been completed, plans to educate fellow CRNAs and anesthesiologists are in place, and follow through with any further needs will be identified and organized to create successful change within the department. Educational lectures and handouts on the importance of evidence-based practices for improving patient outcomes will be provided. Education to re-introduce the ACT to dexmedetomidine with an overview presentation has been delivered. At this time, materials such as intravenous pumps, tubing, and medication are currently at adequate levels to support the research into dexmedetomidine usage.

The roles of the change agent (primary investigator) have been identified as expert and facilitor regarding the research and use of dexmedetomidine. ACT members including anesthesiologists, CRNAs, and SRNAs, currently look to the change agent for support and knowledge for the administration and management of dexmedetomidine in many different anesthetic scenarios. The research and evidence-based education completed by the change agent will enhance the expert status of the change agent as understood by essential team members.

Change maintance will occur via continous communication via educational sessions, along with in-operating room support for CRNAs regarding dexmedetomide usage, and constuctive feedback from ACT members on potential improvements. The ultimate impact of the evidence-based research and ACT education will be improved anesthetic care for all patients, but specifically neurosurgical patients for this schoraly project.

The slow termination of the change agent will occur once the staff CRNAs are comfortable with the use of the dexmedetomidine. Nevertheless, this project has potential to be an ongoing endeavor with additional research using a possible prospective pilot study and further site-specific retrospective data collection and analysis. The utilization of neurosugical dexmedetomidine will needed to be updated and modified as new knowledge is gained and usage is incorporated into the culture of the ACT.

Leadership and Inter-professional Collaboration

Conner (1992) noted that there are four distinct characters critical to the change process: sponsors, agents, targets, and advocates. It is essential to involve these key participants in order to contribute to actual and persisting change. The sponsors of the change project to increase dexmedetomidine awareness will be the anesthesia department director and managers, as these individuals have the power to approve and endorse the project. The author will be the agent for successful change. Best practices research has been completed; barriers have been identified; action plans have been constructed to resolve problems; and research development is underway. Staff CRNAs at PHR are the targets for the project. The core team of neuro-anesthetists has expressed interest in assisting with the education of fellow CRNAs, SRNAs, and anesthesiologists. The advocates for this project will be the neurosurgeons and otolaryngologists. Research findings will be presented to the chief neurosurgeon to acquire key advocate buy-in for the continued research.

Change in any organization can be stressful and demanding for all involved parties. It is important to create teams that will effectively endure stressful situations. According to Hughes and Terrell (2007), stress tolerance is the ability to keep unpleasant surprises at bay, which can be accomplished by emotional and physiological stress management. There are seven components of stress tolerance that will be incorporated into the project team consisting of sponsors of change (anesthesia director and managers), agents of change (author and core neuro-CRNAs), and advocates of change (neurosurgeons and otolaryngologists):

1. Environmental awareness. It is necessary for the group to recognize the fast-paced and complex environment of neuro-anesthesia and desire to integrate new knowledge into anesthetic plans.
2. Assertiveness. The group agents must display assertiveness that depicts a sense of urgency to drive the successful change of anesthesia practice.
3. Self-regard. Each team member must demonstrate self-regard, knowing when to ask for assistance in overcoming barriers to change.
4. Wellness. Physical fitness is the key to help relieve stress and put the mind at ease.
5. Humor. Laughter is the best medicine. It is essential for the well-being of the mind and soul to find humor in situations.
6. Flexibility. Being a successful team member requires a degree of flexibility, when new research can be published at any time and become accepted practice.
7. Humility. Humility is something many healthcare providers know all too well. Humility allows healthcare professionals to depend on each other for support during the good times and bad times (Hughes & Terrell, 2007).

One of the most enduring ways to build stress tolerance is by building strong relationships among team members (Hughes & Terrell, 2007). By knowing each other's strengths, complementing them, and working together, the team achieves its power (Hughes & Terrell, 2007).

Effective teamwork has been related to a reduction of medical errors, improved quality of care, increased patient satisfaction with care, improved provider role clarity, and better inter-professional collaboration (as cited in Kilpatrick, Lavoie-Tremblay, Ritchie, & Lamothe, 2014). With the transition to value-based healthcare and pay-for-performance models, PHR must encompass enhanced quality of care, increased patient satisfaction, and cost cutting mechanisms to maintain a competitive edge against other healthcare systems. Applying effective team involvement in dexmedetomidine awareness and research will satisfy these objectives.

Challenges to Change

Uncontrollable. Numerous challenges have been identified that may lead to resistance to the future scholarly research. The uncontrollable barriers to further research includes IRB and/or PHR denial of retrospective chart data collection, IRB and/or PHR denial of prospective pilot study utilizing dexmedetomidine in transsphenoidal tumor resections, and inability to obtain dexmedetomidine either from the manufacturer or hospital. In these uncontrollable situations, there is no choice but discontinue the research.

Adaptable. The adaptable resistors to change include ACT resistance to changing perceptions on dexmedetomidine and limitations to data collection. The challenges can be displayed as CRNA resistance to dexmedetomidine use and data collection, anesthesiologist request to eliminate dexmedetomidine from the anesthetic plan, and limitations to collecting reliable data. To address these resistors to change, education, utilizing evidence-based approaches, will be the focus to drive the planned change in the anesthesia department at PHR. To ensure buy-in from leadership, education will begin with the department management team. Management support of implementing evidence-based research will ensure confidence among the team and will allow further CRNA education to occur. A multimedia approach will be taken for the education of the CRNA teams via lecture, PowerPoint presentations, active group discussion, and self-instruction via supplemental handouts.

After approval from the PHR anesthesia management, the first ACT educational session occurred on May 17, 2017 with the presentation, “A Brief Overview of Perioperative

Dexmedetomidine" (Rogers, 2017), to increase the awareness of dexmedetomidine. The objectives for this presentation were: the learner will be able to discuss dexmedetomidine pharmacology; preoperative, intraoperative, and postoperative indications; contraindications; adverse effects and treatment; and intravenous pump set-up for boluses and infusions. For this, and subsequent, educational sessions, Malcolm Knowles' Andragogy was combined with his Self-Directed Learning to form the theoretical basis for the learning sessions (Smith, 2002). Along with the staff CRNAs at PHR, the student nurses anesthetists and anesthesiologists were also invited to participate in the presentation. Additional presentation copies were delivered via email to those who were unable to attend the educational session. Copies of the presentation were readily available in the CRNA, anesthesiologist, and SRNA lounges.

Further educational sessions will be scheduled after completion of the scholarly project dissemination. These educational presentations will include findings from of the scholarly project on the use of dexmedetomidine during transsphenoidal tumor resections and an introduction to further research modalities. The core neuro-CRNA team will be designated as dexmedetomidine use champions to provide in-operating room support and reinforcement as needed in future research endeavors.

Implementation Methods

This scholarly project was presented to key stakeholders, which include the PHR nurse anesthesia management team, the Doctorate of Nurse Anesthesia Practice (DNAP) program mentor at MUSC, the DNAP mentor at PHR, PHR neurosurgeons, ENT surgeons at PHR, and to the CRNAs and anesthesiologists practicing at PHR. Support from the anesthesia management, MUSC advisor, PHR mentor, PHR CRNAs, and PHR information technology department was essential. Identifying and including key stakeholders allowed for the literature review and retrospective chart review to be timely and successful. Institutional Review Board (IRB) approval was obtained from both MUSC IRB and PHR IRB prior to the retrospective chart review data collection.

Literature Review

A literature review was completed to determine if the evidence supports the use of dexmedetomidine as a beneficial adjuvant to the anesthetic management of transsphenoidal tumor resections. The literature review confirmed the benefits of adding dexmedetomidine to the anesthetic management of patients undergoing transsphenoidal resections of tumors. This led to a site-specific retrospective chart review.

Retrospective Chart Review

A retrospective chart review was conducted from February 19, 2017 to April 1, 2017 on adult patients at PHR who underwent transsphenoidal resections of tumors between January 1, 2011 and January 25, 2017. The data collection tool included 68 data points (Appendix C). The tool included demographics, diagnosis, surgical procedure, American Society of Anesthesiologists (ASA) physical status classification, time stamps, hemodynamics, and medications administered.

Challenges and Solutions

Literature review and retrospective chart review. Many challenges were unveiled gathering data for the literature review and retrospective chart review. The first challenge to data collection was the time constraints of the doctoral program. A limited amount of time could be spent researching, reviewing, and analyzing the data from the literature review before progressing to the next phase of the scholarly project. The next challenge to gathering adequate data for the literature review was the limited amount of published research on the use of dexmedetomidine during neurosurgery, with and without using the transsphenoidal approach.

The retrospective chart reviews offered distinct challenges of locating relevant information in an electronic medical record with both computerized and paper charting. Many of the older charts contained hand-written documentation, such as progress notes and discharge criteria, with some being illegible. As the charting progressed in time, hand-written notes were eliminated and computer documentation ensued. The computerized documents were difficult to locate with some data points found under inconsistent sub-sections of the medical record. Once the information was located, inconsistences were noted in documentation of actual PACU and ICU admission and discharge times. Discrepancies were also noted between the circulating Registered Nurse (RN) and CRNA documentation such as end of surgery time, extubation time, and admission to PACU times. Some of the time stamps were compiled from partial documentation from the circulating OR nurse, PACU nurse, ICU nurse and CRNA anesthesia record. The hand-written, paper anesthesia record had the potential for errors or omissions of vital signs and/or exact times for the administration of medications. Many of these inconstancies may have been avoided with the use of a system-wide electronic medical record.

Data Analysis

Data were collected and analyzed throughout the scholarly project. Once the need for a critical change was identified, data were collected first through a comprehensive literature review, and then synthesized in an integrative review. The integrative review supported the use of dexmedetomidine to achieve hemodynamic stability, decreased use of narcotics and anesthetic agents, shortened length of stay, and improved patient care during intracranial procedures. Site-specific data were then collected through retrospective chart reviews of transsphenoidal approaches to intracranial tumors. These data were then analyzed to determine if the intraoperative use of dexmedetomidine compared to not using dexmedetomidine offered the benefits of improved hemodynamic control, less narcotic and anesthetic agent use, shortened length of stay, and improved patient care that were identified through the integrative review.

Results

Statistical analysis of the retrospective chart review data was completed by the Research Division of Palmetto Health. The Wilcoxon Rank-sum test, or Mann-Whitney U-test, was used to analyze the data and to determine any significant values. The Wilcoxon Rank-sum test is a non-parametric test comparing two independent samples. In this case, the Wilcoxon Rank-sum test was used to compare the medians between two populations: the dexmedetomidine group and the non-dexmedetomidine group.

Table 2 illustrates the findings of the site-specific retrospective chart review on the effects of dexmedetomidine during transsphenoidal surgery. The inclusion criteria included: adult patients at PHR, aged 18 to 85, who have undergone a transsphenoidal approach for the resection of tumor between January 1, 2011 and January 25, 2017. The exclusion criteria included: preoperative admission to the ICU, artificial airway upon arrival to the operating room, a diagnosis of uncontrolled hypertension, immediate or same day use of an angiotensin converting enzyme inhibitor or angiotensin II receptor blockers, same procedure re-operation, and intraoperative mortality. A total of 34 patients met the inclusion criteria. Age ranged from 22 to 79 years with a mean patient age of 57. Seventeen participants identified as male and 17 as female. Racially, participants self-identified as follows: 11 patients as white, 20 as black, and 3 as multiple races. The diagnosis of pituitary tumor was given to 28 patients. Two patients were diagnosed with a clival tumor, one patient with a chordoma, one patient with a pituitary microadenoma, one patient with a sellar lesion, and one patient with a recurrent pituitary tumor. All experienced surgical procedures were via the transsphenoidal approach. The ASA patient status classification ranged from PS2 to PS4. Intraoperative dexmedetomidine was utilized in only 6 of the 34 patients.

Clinical Results

Hemodynamics. In order to measure hemodynamic stability, the MAP was calculated using a standard formula of [(2 x DBP) + SBP]/3. The MAP in the dexmedetomidine group had a mean decrease of 22.2 mmHg from the baseline; in the non-dexmedetomidine group, the MAP decreased by a mean of 7.9 mm Hg from the baseline. The dexmedetomidine group had a MAP range of -38 to -8 change from the baseline MAP. The non-dexmedetomidine group had a MAP range of -31 to +34 change from the baseline MAP. The Wilcoxon Rank-sum test p-value was .036, which is statistically significant.

Narcotic usage. The narcotic usage was determined by converting all opioids to morphine milligram equivalents (MME), using the John Hopkins Opioid Equivalency Table (Nesbit, 2017). The dexmedetomidine group had a mean of 171 MME with a maximum of 328 MME. and the non-dexmedetomidine group had a mean of 80 MME with a maximum of 353 MME. The Wilcoxon Rank-sum test p-value was .16, not statistically significant.

Extubation profile. The extubation profile was established by using the end of surgery time and the documented extubation time. In the dexmedetomidine group, the minimum extubation time was 12 minutes with a mean of 18.5 minutes. In the non-dexmedetomidine group, at least one patient remained intubated postoperatively, so the minimum extubation time is zero; this group had a mean time of 36.9 minutes from the end of surgery to extubation. The Wilcoxon Rank-sum test p-value was .535, which is not statistically significant.

Recovery profile. The recovery profile was ascertained by using the PACU admission time and the PACU anesthesiologist sign-out time, or when the patient meets Aldrete score criteria for adequate recovery from anesthesia.

The dexmedetomidine group spent a minimum of 15 minutes and a mean of 51 minutes in the PACU. The non-dexmedetomidine group had a minimum of 18 minutes and a mean of 54 minutes in PACU to meet Aldrete score criteria. The Wilcoxon Rank-sum test p-value was .548. One non-dexmedetomidine patient was directly admitted to ICU from the OR secondary to critical patient status.

ICU length of stay. The ICU length of stay was measured in days spent in ICU. The dexmedetomidine group had a mean of 1.75 days, and the non-dexmedetomidine group had a mean of 1.92 days in ICU. The Wilcoxon Rank-sum test p-value = .923.

Discussion

Dexmedetomidine was introduced to the pharmaceutical market in 1999 after having gained Federal Drug Administration approval. In 2004, PHR added dexmedetomidine to the hospital formulary, but it was not routinely administered as an anesthetic adjuvant until 2012. As the data show, from 2011 to 2015, a total of 25 transsphenoidal procedures were performed at PHR. Beginning in 2016, with the arrival of an innovative neurosurgical team, the number of transsphenoidal surgeries increased to a total of 17 surgeries between January 2016 and January 2017.

Clinical Implications

Hemodynamics. No patients in the dexmedetomidine group received additional medications, such as propofol boluses, labetalol, esmolol, metoprolol, nitroglycerine, hydralazine, or nicardipine, to control hemodynamic elevations. Three patients in the dexmedetomidine group received neosynephrine for the of treatment low blood pressure. In the non-dexmedetomidine group, one patient received a propofol bolus, one patient was given labetalol, three patients received esmolol, four patients were given metoprolol, two patients were given hydralazine, two patients received nitroglycerin, and three patients received nicardipine, with all medications administered intravenously. Nitroglycerin and hydralazine have side effects that may cause detrimental neurological effects. To increase blood pressure, eight patients in the non-dexmedetomidine group received neosynephrine and one patient was given ephedrine. Based on the extensive range of MAP's in the non-dexmedetomidine group, -31 to +34, it is proposed that the dexmedetomidine group had more predictable changes in hemodynamics.

Before 2016, and the arrival of the new neurosurgical group, there was no urgency to enlist strict blood pressure control measures for transsphenoidal surgery. Prior to that time, none of the neurosurgeons used intraoperative neuromonitoring for these procedure, thus allowing for the use of neuromuscular blocking agents combined with lower minimum alveolar concentrations of anesthetic agents to achieve a normotensive state. During surgical procedures that utilize intraoperative neuromonitoring, however, the anesthetist must adhere to certain anesthetic agents and adjuncts to decrease the known effects of high levels of anesthetics to allow for precise neuromonitoring. Furthermore, in the past, no restriction was mandated by the neurosurgeons on the agents used to control blood pressure.

From the author's experience incorporating dexmedetomidine into the anesthetic plan, the hemodynamic profile was smooth, with little variation from the patient's baseline blood pressure parameters. The concurrent administration of a remifentanil infusion was present on each patient in which dexmedetomidine was used. There is some argument that the infusion of remifentanil contributed to the pattern of hemodynamic stability. Further investigation is warranted to determine if the administration of dexmedetomidine, remifentanil, or a combination played a role in hemodynamic control.

Narcotic usage. Opioid-based narcotics were dispensed in both the dexmedetomidine group and the non-dexmedetomidine group. Remifentanil was infused in five, or 83%, of the patients in the dexmedetomidine group. In the non-dexmedetomidine group, seven patients, or 25%, received a remifentanil infusion. Fentanyl was administered to two patients in the dexmedetomidine group and 19 patients in the non-dexmedetomidine group. One patient in both the dexmedetomidine and the non-dexmedetomidine group received morphine. No patients received hydromorphone for pain control.

The number of MMEs in the dexmedetomidine group was large due to the MME of remifentanil. The MME of remifentanil is equal to the MME of fentanyl, but is metabolized in a different manner. Remifentanil has an ultra-short acting half-life of 3-5 minutes and metabolism by nonspecific blood and tissue esterases (Glass, Gan, & Howell, 1999). Remifentanil must be administered as an intravenous infusion for the duration of the surgical procedure to maintain adequate pain control and to augment the anesthetic agent for the desired surgical anesthetic plane (Glass et al., 1999). Unlike other opioids, remifentanil does not accumulate in the system and has no residual effects (Haigh, 2000). Therefore, higher doses can be used with no lasting effects after discontinuation.

None of the site-specific chart reviews showed any anesthetic plans using an opioid-free anesthetic technique. Opioid-free anesthetic techniques for intracranial tumor resection via the transsphenoidal approach have the potential to be feasible with adequate local anesthetic infiltration by the surgeon into the surgical field. Further research, possibly with the use of a pilot study omitting the use of remifentanil, may be required to determine if the addition of dexmedetomidine truly decreased the amount of MMEs needed to control pain adequately.

Anesthetic agent usage. Data were not collected on the amount of anesthetic agent administered, either inhalational or intravenous. Therefore, the current review is unable to determine if the use of dexmedetomidine had an effect on anesthetic agent use. Variables that need to be assessed in the future to determine a reduction in anesthetic agent with the use of dexmedetomidine include: (a) the recent use of intraoperative neuromonitoring and the restriction of certain anesthetics; (b) the anesthetists personal preference of anesthetic delivery and the agents used; and (c) the use of neuromuscular blocking agents and the reduction of anesthetic agents administered on certain patients.

Extubation profile. Data analysis of the extubation profile revealed an 18 minute difference in extubation time between the dexmedetomidine and non-dexmedetomidine groups. Statistically this not significant, but clinically, 18 additional minutes in the OR significantly decreases the efficiency of the perioperative suite. These additional minutes spent in the OR attempting to extubate a patient can be costly for both the patient and the hospital organization.

The site-specific extubation profile data may be limited due to inadequate documentation by the anesthesia provider of actual time of extubation and inaccurate or missing documentation of actual surgical end time by the OR nurse. Future data collection should be more precise with the meticulous use of electronic medical record documentation by the CRNA and/or circulating OR nurse.

Recovery profile. Calculating the recovery time from PACU admission to PACU sign-out time allows the researcher to eliminate consideration of variables such as the holding of patients in PACU due to lack of ICU beds and/or the holding of patients by the PACU staff. One variable that was not accounted for was the potential time spent in the OR after surgery completion awaiting a bed in PACU. Under the circumstances such as staffing inadequacies, electronic medical record charting, and lack of physical space may account for the times a patient would spend in the OR awaiting a recovery bed. Unless there is a prolonged hold for a PACU bed, this information is not routinely documented.

Currently, there is no ideal way to determine the exact PACU length of stay. The researcher has no influence on PACU management or staff to expedite postoperative patients to the next in-house destination. Further site-specific research is required to determine actual time spent in recovery after anesthetic techniques utilizing dexmedetomidine.

ICU length of stay. The ICU length of stay data has the potential to be limited due to unforeseen complications due to surgery and/or lack of documentation of actual ICU discharge time. The ICU length of stay may also have been prolonged due to lack of inpatient floor beds. The author attempted to eliminate this variable by using the actual time of ICU discharge by the physician or advanced practitioner. Because of the inadequate documentation, there was no concrete way to determine precisely if a patient required ICU care.

Cost analysis. The cost analysis was not prepared due to the limitations of the IRB approval for total surgical time. The total surgical time for both groups would be required to analyze any cost differences incurred by utilizing dexmedetomidine.

Limitations

Based on the sample size (n = 34) of retrospective chart reviews and the sample size (n = 6) of the patients who received intraoperative dexmedetomidine, the statistical power of results is low and the variability of the study is high, which prohibits generalizing the findings to the entire population of transsphenoidal surgical patients. According to Button et al. (2013), a study with low statistical power has a reduced chance of displaying a true effect. Low power also reduces the likelihood that a statistically significant result reflects a true effect (Button et al., 2013).

Future Research

Over the past year of the scholarly project, the ACT at PHR have been continually exposed to the latest research and methods for the use of dexmedetomidine for the anesthetic management, not only of transsphenoidal surgery, but all neurosurgical patients. The exposure, encouragement, and knowledge provided by the author have dramatically increased the comfort level of CRNAs and the perceptions of dexmedetomidine use. If IRB approval is obtained to further collect site-specific retrospective data and a prospective pilot study on dexmedetomidine use in transsphenoidal tumor resections is granted, then further research will begin. The Research Division at Palmetto Health will be consulted to help facilitate study design, implementation, and analysis of the results.

Further data collection is needed to make a determination of statistically significant benefits of dexmedetomidine use in transsphenoidal surgery. This scholarly project could be built upon through a prospective study to analyze the effects of intraoperative dexmedetomidine on hemodynamic control, narcotic usage, anesthetic agent usage, recovery profile, and length of stay.

Conclusion

The goal of the IOM roundtable on evidence-based medicine “is that by 2020, 90 percent of clinical decisions will be supported by accurate, timely, and up-to-date clinical information and will reflect the best available evidence” (IOM, 2009, p. 1). This scholarly project builds upon the IOM’s goal by researching best evidence-based practices for implementing the use of dexmedetomidine for transsphenoidal surgeries. According to the literature review, the evidence validates the intraoperative use of dexmedetomidine to improve patient outcomes. Although the retrospective data were inconclusive, post-doctoral work will continue with additional research on the use of dexmedetomidine during transsphenoidal pituitary tumor resections.

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Table 1

Dexmedetomidine Literature Review

Author, Date	Study Purpose	Sample Description	Study Design	Data Collection Methods	Results	Level of Evidence (OCEBM, 2011)
Alfonso & Reis, 2012	Update and review DEX in anesthesia and ICU	N/A	Comprehensive review of DEX	Comprehensive review	DEX has sedative, analgesic, anxiolytic, sympatholytic, opioid-sparing properties; neuroprotective	1: SR of RCT
Bekker et al., 2008	Assess DEX in controlling hypertensive responses in intracranial surgery	72 elective craniotomies; 14 excluded, ages 18-65 years	Prospective, RCT, double-blind, placebo controlled	Intraoperative data from anesthesia machine and monitor, PACU data from records	Intraoperative DEX improved hemodynamic stability, faster PACU discharge	2: RCT
Bekker & Sturaitis, 2005	Neuropharmacology and neurophysiology of a2 adrenergic agonists	N/A	Comprehensive review of DEX	Comprehensive review	DEX offers antinociception, anesthetic-sparing effects, cardiovascular stability, minimal respirator depression, no effect of ICP, neuroprotective	3: Topic review
Brady, 2010	Investigation of the off-label use of DEX as an anesthesia adjunct for adult transsphenoidal pituitary resection	1	Case report	Direct observation	50% reduction in volatile agent	4: Case study
Gopalakrishna et al., 2015	Evaluate the effect of DEX on perioperative hemodynamics, anesthetic	46 elective surgical patients, randomly allocated into 2	Prospective, randomized, double-blind placebo controlled study	Direct observation	DEX group – 20% decrease in fentanyl; decrease in EtIso less blood loss; decrease in MAP; shorter emergence	2: RCT

	requirements, and recovery characteristics in patients undergoing transsphenoid resection of pituitary tumors	groups			and extubation; better Aldrete score at 10 min; less PONV	
Gurbet et al., 2006	Effect of intraoperative DEX on postoperative analgesia for abdominal hysterectomy	50 women, randomly assigned to 2 groups	Prospective, randomized, double-blind	Direct observation of HR, SpO2, BP intra- and postoperatively; VAS for pain; time to extubation	Both groups with similar time to extubation, DEX group consumed less morphine, had less nausea, vomiting, and itching postoperatively	2: RCT
Hofer et al., 2005	Describe DEX for narcotic substitution in anesthetic management of extremely obese	1	Case report	Direct observation, VAS for pain	Narcotic-sparing effect evident intra-and postoperatively	4: Case study
Ilhan et al., 2010	Comparing fentanyl with DEX in hemodynamic response, recovery criteria, postoperative shivering, nausea, vomiting in supratentorial craniotomy	30 patients, ASA PS 1 & 2, ages 18-65	Randomized double-blind, prospective clinical study	Direct observation of EKG, HR, BP, MAP, ETCO2, SpO2; Aldrete score; total DEX and fentanyl use	DEX group with more cerebral relaxation, lower MAP & HR, shorter recovery time, and postoperative side effects	2: RCT
Patanwala & Erstad, 2016	To compare total hospital costs and length of stay in patients who received DEX v. propofol for ICU sedation	3294 patients, 2685 received propofol & 609 received DEX	Retrospective quality improvement	Retrospective data review, multivariate regression models developed	DEX use associated with increased total hospital costs, ICU and hospital length of stay compared to propofol.	2: Retrospective quality improvement
Peng et al.,	Effect of	80 patients; 2	Randomized	VRS, direct	Intraoperative DEX	2:

2015	intraoperative DEX on postoperative pain, analgesic consumption, and adverse effects after craniotomy	excluded, randomized into 38 in DEX group, 38 in placebo group	double-blind, placebo controlled	observation	infusion effective in reducing post-craniotomy pain and opioid use	RCT
Peng et al., 2014	To collect current evidence regarding the efficacy and safety of DEX as an anesthetic adjuvant for patients undergoing intracranial surgery	Total 655 articles, 19 studies potentially eligible, 389 participants were included, adults	Meta-analysis of 8 RCTs	Systemic review of RCT according to PRISMA guidelines	Shows evidence that DEX is safe and efficacious anesthetic adjuvant in intracranial procedures	1: SR of RCT
Rajan et al., 2016	Effects of DEX and remifentanil on hemodynamics and analgesia after craniotomy	142 randomized patients, 3 excluded, 139 remaining patients, 68 assigned to DEX, 71 assigned to remifentanil	RCT	Direct observation, VAS for pain	Intraoperative DEX provided better controlled postop MAP, less opioid consumption	2: RCT
Salimi et al., 2014	To determine to effect of DEX on bleeding, surgeon satisfaction, hemodynamic stability in patients undergoing transsphenoidal resection of pituitary tumor	60 elective surgical patients, randomly allocated into 2 groups	Randomized double-blind clinical trial	Direct observation, data recording at baseline and every 30 min; estimated blood loss; surgeon satisfaction stratified as excellent, moderate, poor at end of surgery	DEX group with significantly lower propofol and fentanyl use; lower bleeding amount; higher surgeon satisfaction; significantly lower HR and MAP	2: RCT
Schnabel et al., 2013	Efficacy and safety of DEX compared	1420 patients	Meta-analysis including 28	SR of RCT according to the	Intraoperative DEX significantly decreases	1: SR of RCT

	with placebo or opioids for acute postoperative pain		RCTs	PRISMA guidelines	postoperative pain intensity and has opioid sparing effect	
Shin et al., 2013	Evaluation of pre-anesthetic DEX on sedation, hemodynamics, anesthetic consumption, and recovery profiles	42 female patients undergoing gynecological surgery, randomized into 2 groups	Controlled double-blind, randomized	Direct observation of BIS, MAP, HR; dose of sevoflurane; Aldrete score; VAS pain score; response to verbal commands; time to extubation; PONV	Pre-anesthetic DEX maintains stable hemodynamics, decreased anesthetic consumption with no change in recovery profile	2: RCT
Soliman et al., 2011	Assess perioperative effect of intraoperative DEX in craniotomy for supratentorial tumor	40 patients; randomized into DEX and placebo groups	Prospective randomized double- blind study	Direct observation of HR, MAP, CVP; intra-op drug use for hemodymanic disturbances; PaCO2; ICP; GCS; total fentanyl use; duration before extubation; EtSevo; surgical duration	Continuous intraoperative DEX infusion maintained hemodynamic stability; reduced sevoflurane and fentanyl requirements; decreased intracranial pressure; improved outcomes	2: RCT
Song et al., 2016	To evaluate opioid-sparing effect of intraoperative DEX after craniotomy	60 adults randomized into 2 groups receiving DEX or saline	Randomized controlled trial	NRS and RSS scores	Intraoperative DEX reduced morphine consumption; lower NRS and RSS	2: RCT
Srivastava et al., 2014	Comparison of propofol, DEX, and midazolam for short term sedation	90 adults, randomized into 3 groups of 30	Prospective randomized patient-blinded	HR, MAP; sedation level; fentanyl requirement; ventilation and extubation	DEX is safer and equally as effective as propofol and midazolam; DEX group with less fentanyl needs, lower HR, decreased MAP	2: RCT
Tanskanen et al., 2006	DEX as anesthesia adjuvant in intracranial tumor surgery	53 patients for elective supratentorial brain tumor,	Double-blind randomized parallel group trial	Direct observation of HR, BP; serum DEX concentration; PaCO2; isoflurane	DEX increased perioperative hemodynamic stability; attenuated emergence	2: RCT

		randomized into 2 groups to receive DEX or placebo		use; intraoperative use of hemodynamic interventions	from anesthesia	
Turan et al., 2008	Effect of DEX on hemodynamics and recovery for intracranial surgery	40 patients; randomized into 2 groups; 20 in DEX group, 20 in saline group	Randomized control trial	Direct observation of BP, MAP, HR before, and during infusion; after extubation; 5-point scale to measure extubation quality	Single bolus of DEX 0.5 mcg/kg stabilized HR and BP after extubation; did not prolong recovery	2: RCT
Uyar et al., 2008	Sympatholytic effects of DEX on hemodynamics and stress hormones to skull pinning	40 patients undergoing elective craniotomy with skull pin head holder randomized into 2 groups, DEX and placebo	Prospective double-blinded study	Observation of MAP, HR; blood samples for plasma glucose, insulin, cortisol, prolactin levels	Preoperative DEX can be a useful adjuvant in neurosurgical procedures; attenuates hemodynamic and neuroendocrine response to skull pinning	2: RCT
Yun et al., 2016	Investigating the hemodynamics after single bolus of DEX, effect on emergence hypertension and post-surgical pain	134 patients; randomized into small dose DEX, median dose DEX, or control group	Prospective double-blinded study	Direct observation of HR, MAP; eye opening to verbal command; NRS pain score; cough after extubation; PONV; shivering	Useful adjuvant to control emergence hypertension and reduce post-surgical pain; transient intraoperative hypertension; dose-related pain relief; anti-shivering effect	2: RCT

Note: DEX = dexmedetomidine; ICU = intensive care unit; SR = systematic review; RCT = randomized control trial; PACU = post-anesthesia care unit; ICP = intracranial pressure; EtISO = end tidal isoflurane; PONV = postoperative nausea and vomiting; VAS = visual analog pain scale; ASA PS = American Society of Anesthesiologists physical status; EKG = electrocardiogram; HR = heart rate; BP = blood pressure; MAP = mean arterial pressure; EtCO2 = end tidal carbon dioxide; SpO2 = peripheral capillary oxygen saturation; VRS = verbal pain rating scale; PRISMA = preferred reporting items for systematic reviews and meta-analyses; BIS = bispectral index; CVP = central venous pressure; PaCO2 = partial pressure of arterial carbon dioxide; GCS = Glasgow coma scale; EtSEVO = end tidal sevoflurane; NRS = numerical pain rating scale; RSS = Ramsay sedation scale.

Table 2

The Effects of Dexmedetomidine in Transsphenoidal Surgery (mean ± SD)

	DEX group (n = 6)	Non-DEX group (n = 28)
Demographic profile		
Age (yr)	60.8 ± 14.9	56.6 ± 12.8
Gender (male:female) (n)	4:2	13:15
Race (white:black:multiple) (n)	1:4:1	10:16:2
Clinical profile		
ASA PS (1:2:3:4) (n)	0:0:4:2	0:4:21:3
Diagnosis		
Pituitary tumor	5	24
Clival tumor	1	1
Chordoma	0	1
Pituitary microadenoma	0	1
Sellar lesion	0	1
Recurrent pituitary tumor	0	1
Surgical procedure[a]		
Clival lesion resection	1	0
Pituitary resection	5	25
Resection of chordoma	0	1
Resection of clival tumor	0	1
Resection of sellar lesion	0	1
Hemodynamic profile (MAP mmHg)	-22.2 ± 11.27	-7.9 ± 15.72
Narcotic use (MME)	171.1 ± 120.84	80.29 ± 110.54
Extubation profile (min)	18.5 ± 8.06	36.93 ± 111.22
Recovery profile (min)	51.17 ± 35.28	54.08 ± 26.41
ICU length of stay (days)	1.75 ± 0.96	1.92 ± 1.23

Note. DEX = dexmedetomidine; SD = standard deviation; ASA PS = American Society of Anesthesiologists physical status. [a]Surgical procedures performed via the transsphenoidal approach.

Figures

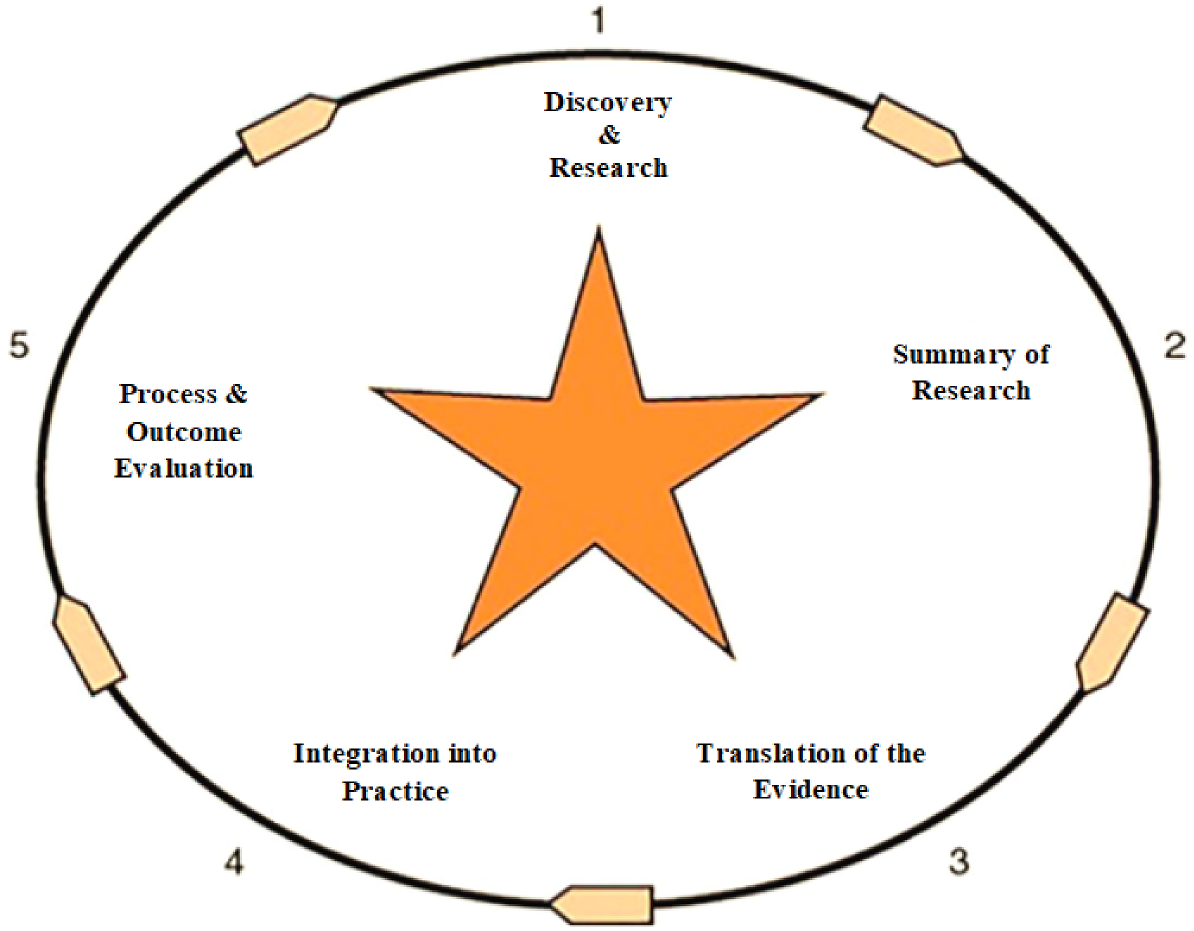

Figure 1. Adaptation of Stevens' (2012) Star Model of Knowledge Transformation.

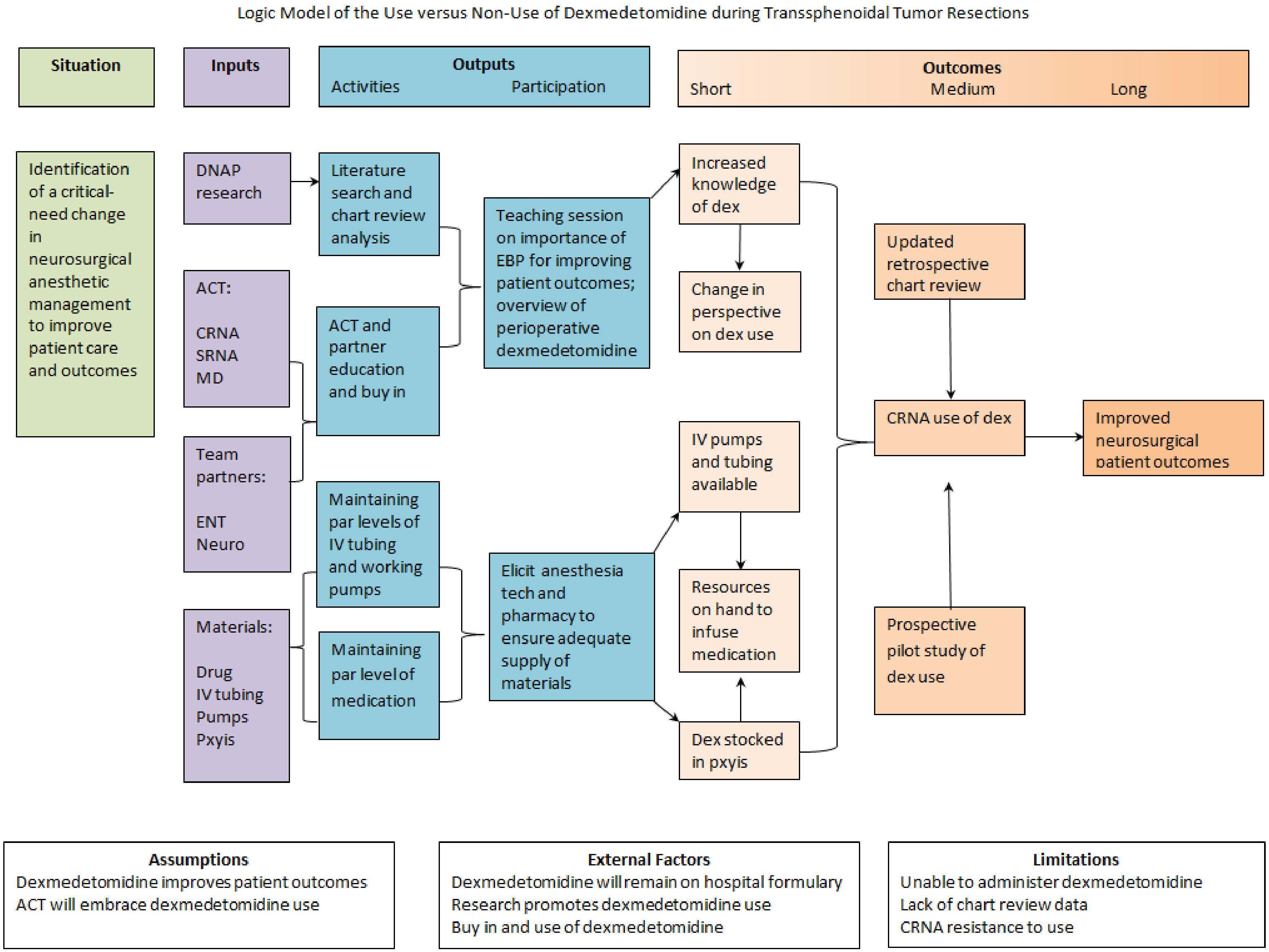

Figure 2. Logic Model of the Use Versus Non-use of Dexmedetomidine during Transsphenoidal Tumor Resections

Appendix A

Medical University of South Carolina Institutional Review Board Approval

MUSC
MEDICAL UNIVERSITY
of SOUTH CAROLINA

Institutional Review Board for Human Research (IRB)
Office of Research Integrity (ORI)
Medical University of South Carolina

Harborview Office Tower
19 Hagood Ave., Suite 601, MSC857
Charleston, SC 29425-8570
Federal Wide Assurance # 1888

APPROVAL:
This is to certify that the research proposal **Pro00062606** entitled:
Improving the quality of anesthesia care for patients undergoing tumor resections via the transsphenoidal approach utilizing dexmedetomidine.

Submitted by: **Lisa Rogers**
Department: **Medical University of South Carolina**

for consideration has been reviewed by **IRB-I - Medical University of South Carolina** and approved. In accordance with 45 CFR 46.101(b)(2), the referenced study is exempt from Human Research Subject Regulations. No further action or Institutional Review Board (IRB) oversight is required, as long as the project remains the same. However, you must inform this office of any changes in procedures involving human subjects. Changes to the current research protocol could result in a reclassification of the study and further review by the IRB.

Because this project was determined to be exempt from further IRB oversight, consent document(s), if applicable, are not stamped with an expiration date.

Research related records should be retained for a minimum of three years after termination of the study.

Approval Date: **2/4/2017**

Type: **Exempt**

Chairman, **IRB-I - Medical University of South Carolina**
Mark Hamner*

Electronic Signature: This document has been electronically signed by the IRB Chairman through the HSSC eIRB Submission System authorizing IRB approval for this study as described in this letter.*

Appendix B

Palmetto Health Institutional Review Board Approval

Site Participation in a Cooperative Review study: Accepted

Study ID:	Pro00062606
Study Title:	Improving the quality of anesthesia care for patients undergoing tumor resections via the transsphenoidal approach utilizing dexmedetomidine.
PI:	Lisa Rogers
Collaborating Site:	Palmetto Health
Description:	A collaborating institution has accepted participation in this Cooperative Study. To review details, click on the above study ID and navigate to the Cooperative Review Status tab.

Appendix C

Retrospective Chart Review Data Collection Tool

The retrospective chart review data collection tool utilized to organize data for the scholarly project was in Excel format. Due to the size of the tool, the information has been modified as below:

- Study ID
- Demographics
  - Age
  - Gender
  - Race
- Diagnosis
- Procedure
- ASA Classification
- Total OR Time
- Time Stamps
  - Local Anesthetic Injection
  - Procedure End
  - Extubation
  - Transfer to PACU (out of OR)
  - PACU Sign Out (discharged from PACU)
  - ICU Admission Date and Time
  - ICU Discharge Date and Time
- Vital Signs
  - Office BP, HR
  - Pre-Anesthesia Testing BP, HR
  - 1st in OR BP, HR
  - 1st after Local Injection BP, HR
- Medications Given (Range of 1-15)
  - Pre-Injection
  - Intra-Injection
  - Post-Injection