12-2013

General Anesthesia and The Importance of Smoking Cessation

Katie R. Pence

GENERAL ANESTHESIA AND THE IMPORTANCE OF SMOKING CESSATION

by

Katie R. Pence

Bachelor of Science, University of North Dakota, 2006

An Independent Study

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Masters of Science

Grand Forks, North Dakota

December

2013

PERMISSION

Title General anesthesia and the importance of smoking cessation

Department Nursing

Degree Master of Science

In presenting this independent study in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the College of Nursing of this University shall make it freely available for inspection. I further agree that permission for extensive copying or electronic access for scholarly purposes may be granted by the professor who supervised my independent study work or, in her absence, by the chairperson of the department or the dean of the Graduate School. It is understood that any copying or publication or other use of this independent study or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my independent study.

Signature Kristi Pence

Date 7/31/13

Abstract

Despite the known consequences of cigarette smoking, one third of the population of industrialized countries continue to smoke (Rodrigo, 2000). Cigarette smoking alters normal physiologic function of the cardiac and respiratory systems and increases risks in the perioperative period for general anesthesia. Systematic reviews and randomized controlled trials have reached the following conclusion: smokers who stop smoking four to eight weeks prior to a scheduled surgery are less likely to develop complications post operatively. Eight weeks of smoking cessation prior to anesthesia is considered to be optimal. Smokers have been noted to possibly need increased analgesia, sedatives, and non-depolarizing muscle relaxants (Webb et al., 2013). Patients that present for a scheduled surgical procedure require education on the importance of smoking cessation eight weeks before the procedure in order to achieve and sustain success. The information addressed should include decreased perioperative complications, improved pain control, and wound healing. Verbal education and support have been identified as the preferred teaching methods for patients (Webb et al.). Because CRNAs will continue to encounter patients that smoke, it is important to understand the changes this group of patients goes though.

General Anesthesia and the Importance of Smoking Cessation

The smoking of substances dates back to as early as 5000 B.C. In fact, smoking has been an integral part of cultures throughout the world from being a part of religious ceremonies to being considered a sinful act. Cigarette smoking and nicotine abuse is known to be associated with multiple co-morbidities, which are exacerbated during a surgical procedure under general anesthesia (Saha, 2009). Intraoperative and post-operative complications include cardiac, respiratory and decreased wound healing, amongst others (Saha, 2009).

Numerous researchers have looked at the impact of pre-operative teaching that emphasizes the need for smoking cessation as well as how smoking cessation can reduce post-operative risks associated with smoking (Sorenson, 2013). This project will look at how smoking affects anesthetic drugs and other medications as well as the possibility of reducing perioperative complications through pre-operative smoking cessation. Orem's model of Self-Care, with the focus on the prevention of self-harm, will be used to guide this project.

A literature review regarding the pathophysiological changes associated with smoking cigarettes, the implications of cigarette smoking on general anesthesia, and ideal implementation of smoking cessation will be completed. This information will then be disseminated to Certified Registered Nurse Anesthetists (CRNAs) and student registered nurse anesthetists (SRNAs) in North Dakota.

Purpose

The purpose of this independent project is to review the pathophysiology of cigarette smoking in order to identify the anesthetic implications associated with smoking. Additionally, a review and dissemination of the advantages of preoperative smoking cessation will be completed and is vital to both healthcare practitioners and patients. The goal of this project is to review the

current literature and inform CRNAs, SRNAs, and other healthcare practitioners as well as patients of the positive outcomes that can be achieved by cessation of smoking at least eight weeks prior to anesthesia.

When patients receive comprehensive education and support, they are more successful at quitting smoking preoperatively as well as continuing to remain abstinent after surgery (Webb, Roberson & Sparrow, 2013). Pre-operative visits may allow for a teachable moment when a patient is willing to change his or her lifestyle or habits in order to decrease possible surgical complications. Because many smokers were found to have a knowledge deficit regarding the effects smoking has on general anesthesia, they may benefit from a multimodal teaching and support strategy that would encourage them to quit smoking prior to their procedure.

Significance

Many people continue to smoke despite the known consequences, contributing to perioperative complications. Smoking is an addiction that is not only controlled by the drug nicotine, but also by a psychological addiction that includes the actions associated with smoking (Warner, 2007). This problem is significant in that perioperative complications are increased when patients continue to smoke right up until the day of surgery. Cessation for an optimal period of eight weeks decreases respiratory, cardiac and wound healing complications. It also allows smokers to reach the pain threshold and metabolism of non-smokers making post-operative pain management more successful. Decreased wound healing time and increased pain control provide for optimal recovery conditions.

Ideally, CRNAs and other healthcare practitioners who encounter the patient prior to surgery should provide the patient with education regarding the importance of smoking cessation in order to achieve improved perioperative outcomes. Unfortunately, Theadom and Cropley

(2006) found that approximately only 58% of surgeons and 30% of CRNAs include preoperative teaching regarding the importance of smoking cessation to patients prior to an elective procedure. As health care is evolving, it may not be possible or feasible for smoking cessation education to come from the anesthesia team, unless a pre-screening center is in place at the hospital or surgical center. Many facilities currently utilize a system that includes an anesthesia assessment of the patient on the morning of surgery, not allowing the required time to educate patients or implement smoking cessation that would result in significant benefits to the patient. If the health care team does not complete the necessary teaching, a knowledge deficit is likely for the patient. Although health care providers are not able to enforce smoking cessation amongst their patients, providing adequate knowledge in a timely fashion will allow patients to make an informed decision regarding smoking cessation. Disseminating information to CRNAs in order to correct this deficit in patient education is the goal of this project.

Theoretical Framework

Orem's Grand Theory of self-care is the theoretical framework for this project. The theory of self-care is one of three parts of Orem's theory (Tomey & Alligood, 2006). This part of the theory states that everyone is able to care for him or herself and meet personal goals of obtaining health. Self-care is a learned behavior that is influenced by many things including health and nursing. This project addresses the prevention of harm as motivation for patients to take part in smoking cessation prior to general anesthesia.

Orem identified three categories of self-care requisites. The first category is universal self-care requisites, which include habits and maintenance of functioning such as activities of daily living (Biggs, 2008). The second is the development of self-care requisites that are encountered when a person is reacting to a condition or event such as getting married or body

changes in puberty. The last requisite is health deviation of self-care that occurs when a person is suffering from a disease or injury. The process includes: seeking medical care, attending to the effects from the condition, following medical advice, adjusting to perception of self, and living with prolonged effects of the condition (Biggs, 2008). Surgical intervention is included in the third portion of the theory. Assuming a person is seeking medical advice, education regarding unhealthy habits should be addressed to teach about the consequences. Therefore, patients who smoke and are scheduled for elective surgery need education, support, and encouragement to participate in cessation as a means of self-care.

Orem's Self-Care Theory assumes that people are responsible for their own care by the actions they take (Orem, 1991). Each person is an individual whose successful development of self-care requisites is important in their prevention of ill health. A person's understanding and knowledge of a problem are pertinent in developing self-care behaviors. A self-care deficit occurs when a person needs help or support to maintain self-care. Help from a nurse in the form of education may assist in promoting and enhancing healthy behaviors. By providing the knowledge base to change a behavior, the nursing system can be educational as well as supportive. Ideally, a nurse will communicate in an age appropriate manner, attend to the patient's individual needs, and address his or her personal limitations. Orem's theory provides an approach of assistance and allows patients to take control of their choices to improve health or prevent illness (Denyes, Orem & SozWiss, 2001). Education needs to be available in an understandable manner for patients and continued support may be necessary since lifestyle changes are time-consuming and not always easy (Denyes, et al.).

An upcoming surgical procedure can provoke anxiety for many people. Using Orem's theory, this discomfort presents an opportunity to address smoking and the importance of

cessation prior to anesthesia administration and the post-operative process. When provided with adequate education and support, patients often choose to participate in a cessation program to decrease perioperative complications as a self-care.

Definitions

Many terms involving physiology and smoking are used interchangeably. In order to have a complete understanding of the clinical problem, the following terms are defined for clarity of use within this project:

1.) Smoking: refers only to cigarette smoking with the inhalation of nicotine and the chemicals within and excludes other substances such as cannabis.

2.) Cessation: completely stopping cigarette smoking but still may be using nicotine in other forms such as a nicotine patch.

3.) Quitting: Used interchangeably with cessation. Completely stopping cigarette smoking but may still be using nicotine in other forms.

4.) NRT: Nicotine replacement therapy, a pharmacological treatment to replace nicotine provided by a cigarette. May be in the form of patches, gum, nasal spray, inhalers or lozenges (Cropley, Theadom, Pravettoni & Webb, 2007).

5.) Reduction: decreasing the amount of cigarettes smoked overall and may include the use of a nicotine patch to aid in the reduction of cigarettes smoked. Cigarettes are still smoked occasionally.

6.) Teachable moment: when positive behaviors are more likely to be adopted due to motivation from a health experience (Webb et al., 2013).

Process

There has been much research completed on smoking including cessation, post-operative complications and pre-operative teaching mechanisms for cessation; however, research is sparse regarding the combination of these topics. The completed studies support the fact that smoking cigarettes is detrimental to a patient's health and creates other problems that remain unanswered. This review of the literature addresses how smoking affects overall heath, surgical outcomes, medications used by CRNAs and cessation interventions that have been found helpful when used appropriately.

Utilizing access to Cochrane Reviews and the Harley French Library multiple searches were completed at different times over a period of a few years to ensure a well-rounded literature review. After a search of the Cochrane Library utilizing "smoking" as a term lead to 100 results, the search was narrowed to include "pain" and 12 studies were discovered. "Smoking" AND "cessation" as search terms elicited 57 reviews. Four of the studies were reviewed for pertinence, but after reading the articles only one was relevant for this study.

PubMed was a search engine also utilized for the literature review. The first search containing "smoking" AND "anesthesia" resulted in 766 articles, some articles were reviewed and related searches were utilized to maximize possibilities. MeSH terms were used on PubMed to complete the review with the most comprehensive search containing "smoking cessation" AND "intraoperative complication." From this search, articles that had been previously retrieved and utilized were discarded, leaving ten relevant articles for this topic of study. After determining the articles pertaining to the topic, each was found in its full context within the Harley French Library or by use of interlibrary loan. Background pathophysiology of smoking and effects on analgesia and anesthetics were retrieved from MDConsult.com and nurse anesthesia textbooks. The majority of the literature used in this project consists of reviews,

mainly systematic reviews and randomized controlled trials. Despite multiple search attempts, both self-directed and librarian-assisted, a void in the literature became evident, especially randomized controlled trials that address optimal education and interventions for smoking cessation before general anesthesia.

Review of Literature

Approximately 44 million Americans smoke cigarettes on a regular basis. Unfortunately, cigarette smoking and nicotine abuse are associated with intraoperative complications exacerbated by general anesthesia (Saha, 2009). Intraoperative and post-operative complications relating to cigarette smoking include cardiac, respiratory and decreased wound healing, amongst others (Saha, 2009). Smoking cessation prior to surgery and general anesthesia is associated with a significant decrease in these peri-operative complications (Webb et al., 2013) and patient education regarding smoking cessation at least 8 weeks prior to the scheduled general anesthetic is ideal for improved patient outcomes (Sorenson, 2013).

This review of the literature will focus on the pathophysiology of smoking, pharmacokinetics and pharmcodynamics of anesthetic drugs in the smoking patient, wound healing issues, and optimal smoking cessation times.

Pathophysiology of Smoking

Smoking cigarettes is a preventable cause of many health-related diseases and deaths throughout the world (Saha, 2009). People who smoke will live approximately 14 years less than those who do not smoke, and one in five deaths in the United States is related to smoking (Nagelhout & Plaus, 2010). Currently, approximately 44 million adults in the United States smoke (Nagelhout & Plaus, 2010). Therefore, it is inevitable that some of these patients will

present for surgery and general anesthesia with an increased risk of avoidable perioperative complications.

The physiology of cigarette smoking is complex and includes an alteration to many of the physiologic functions of the body, especially the cardiovascular and respiratory system. The cardiovascular system responds to nicotine by vasoconstriction, which leads to increased work of the heart (Rodrigo, 2000). Heart rate, blood pressure, myocardial excitement and peripheral vascular resistance are increased by the stimulation of nicotine. Coronary vascular blood flow is decreased, leading to a decreased supply and an increased demand of oxygen (Naglehout & Plaus, 2010).

Oxygen consumption is increased due to the increased work of the heart. Additionally, carbon monoxide is increased within the bloodstream due to smoking. Carbon monoxide, having a higher affinity for hemoglobin, will take the place of oxygen on the oxygen binding sites on the hemoglobin. Increased levels of carbon monoxide from smoking lead to decreased amounts of oxygen available to the tissues, causing an oxyhemoglobin shift to the left. This shift to the left results in peripheral tissues being unable to receive adequate amounts of oxygen from the hemoglobin as it circulates and since the body is not receiving the oxygen it needs, it increases the production of red blood cells to compensate (Naglehout & Plaus, 2010). The increase in red blood cells increases blood viscosity, making the blood sluggish and increasing the risk for blood clots.

These physiological changes to the respiratory system ultimately negatively impact the body's ability to oxygenate properly. The toxic chemicals of smoking destroy the cilia and mucous becomes thicker, leading to difficulty clearing the airway. The vasoconstriction from the cardiovascular system leads to constriction of the respiratory system resulting in smaller airways.

The smaller airways are further compromised by the decreased ability to make surfactant, which is needed to keep the alveoli open (Rodrigo, 2000).

The cardiovascular and respiratory systems are not the only systems affected by smoking. The entire body compensates in order to maintain homeostasis due to the overall lack of oxygenation and continued exposure to toxic chemicals. Decreased oxygenation throughout the body has systemic effects, contributing to changes in the pharmacokinetics and pharmacodynamics of many drugs.

Nicotine is an alkaloid, which stimulates ganglionic effects, (Naglehout & Plaus, 2010) similar to that of acetylcholine. Nicotine stimulates cholinergic receptors, leading to the release of adrenaline and noradrenaline from the adrenal glands, along with dopamine and endorphins. Euphoria, or a sensation of pleasure, is then experienced by this stimulation, leading to not only a physical addiction, but to a psychological one as well (Saha, 2009). Dopamine release is thought to be the main culprit of physical addiction as it is released in large quantities just as with other addictive drugs (Mason, 2006).

Physiologic changes, which occur immediately upon smoking a cigarette, can lead to long-term diseases and disorders. Cancers linked to cigarette smoking include lung, kidney, cervix and bone marrow. Heart disease and Chronic Obstructive Pulmonary Disease (COPD) are often the result of long-term abuse of smoking cigarettes (Naglehout & Plaus, 2010).

Effects of Smoking on Pharmacokinetics and Pharmacodynamics.

Cigarette smoking alters the metabolism and action of several medications, necessitating an understanding of the changes that occur and the effects it has on anesthesia, particularly general anesthesia. Polycyclic aromatic hydocarbons (PAHs) are carcinogenic substances from smoking that disrupt the cytochrome P450 pathway. Cytochrome P450 is a liver enzyme that is

used in Phase I metabolism of toxins or medications. Many drugs that act on the central nervous system, except for volatile anesthetics, are metabolized by the cytochrome P450 enzyme (Sweeney & Grayling, 2008).

Smoking induces this enzyme that participates in the metabolism of drugs, binding them to that pathway quicker. Enzymes are induced to a greater degree in those smokers who smoke a large number of cigarettes daily. The anesthesia related medications most affected by smoking include the neuromuscular blockers, opioids and sedatives. The effect on volatile anesthetics is controversial, but increased metabolism of these agents, due to the induced cytochrome P450 pathway may be linked to an increase in toxic metabolites (Sweeney & Grayling, 2008). Adanir et al. (2010) investigated how cigarette smoking affected Sevoflurane washout time. In this study patients were not allowed to smoke the day of surgery. Induction of general anesthesia was followed by anesthesia maintenance with Sevoflurane and the opioid remifentanil. Using a *t*-test, they found no statistical difference in wake up time between the smoking groups versus the non-smoking group. Limitations of this study included a moderate sample size, which did not include smokers with a pulmonary disease; also it was not a randomized controlled trial as it was limited to a particular type of surgery and only ASA I and II patients (Adanir et al. 2010). The results of the study did not support the thought that smoking would increase the metabolism or washout time of volatile agents.

Patients who smoke have an increased need for opioids for pain management, especially in the post-operative period (Sweeney & Grayling, 2008). Metabolism of opioids is increased due to the induction of the cytochrome P450 enzyme, which leads to an increased dose requirement. Some opioids are more affected then others by the increased metabolism and the actual mechanism of action is not known. There is a lack of research on the newer synthetic

opioids such as fentanyl but they have also been noted clinically to be required in larger doses in smokers as well (Sweeney & Grayling, 2008).

Steinmiller and colleagues (2012) looked at the amount of opioids used by smokers versus non-smokers in the first 24 hours post-operatively with the use of a patient controlled anesthesia (PCA) machine. This study design was a mixed design between subject factors, smoker versus non-smoker; and within subject factors, the amount of time in recovery before opioids were received. Each patient underwent a joint replacement surgery. In the smokers group, nicotine was discontinued on the day of surgery. After surgery each patient was placed on a PCA for 24 hours and the amount of opioid requested and received was retrieved and analyzed. The results indicated that smokers requested more opioids and received more opioids then did non-smokers (Steinmiller et al., 2012). It is difficult to attribute the increased need and request for opioids to nicotine abstinence only, since the anxiety from not smoking may be part of the reason for the increased pain perception as well. Abstinence from nicotine is associated with increased pain perception and increased opioid use (Sweeney & Grayling, 2008). Nicotine replacement therapy (NRT) was not addressed in this study and therefore is assumed that these results are related to the lack of nicotine only. Further controlled studies are needed to determine if NRT or smoking cessation are reasonable options for reducing opioid needs in the post-operative period (Steinmiller et al., 2012). Limitations for this study included a small sample size (N=13) and that it did not address intraoperative narcotic usage and requirements.

It is believed that non-depolarizing neuromuscular blockers are among medications affected by people who smoke, specifically the need for increased doses to achieve adequate effects. This belief, however, is controversial. Sweeney and Grayling (2008) along with Rodrigo (2000) both identify in systematic reviews that Teirea, Rautoma and Yli-Hankala established in

1996 that increased doses of vecuronium and rocuronium were needed intraoperatively in patients who currently smoked cigarettes. Both systematic reviews reference reports that concluded that increased doses of these drugs may be needed due to the increased metabolism of the drugs. They were unable to determine if nicotine blocked the acetylcholine receptors, therefore requiring an increased doses for adequate response. It is clear that more research is needed in this area.

In 1998, Rautoma and Svartling investigated the effects of smoking, specifically, on the dose requirement of rocuronium. In a randomized open clinical study, 40 patients were anesthetized in a consistent fashion and paralyzed with rocuronium. After identifying individual dose-response curves, boluses were given to maintain neuromuscular blockage of 90% or greater by utilizing electromyography (EMG) of the adductor pollicis muscle. The dose of rocuronium was evaluated for each patient and statistically analyzed using analysis of variance (ANOVA). The test resulted in a statistically significant finding that patients who smoke cigarettes require larger doses of rocuronium then non-smokers. The authors found that the volume of distribution for rocuronium was similar in all patients and hypothesized that patients who smoke cigarettes have increased metabolism of the drug, increasing dose requirements. The limitation noted for this study included a small sample size, which lead to borderline statistical significance. The authors suggested that future research completed on the pharmacokinetic-pharmacodynamics of rocuronium in smoking patients would help clarify the role of metabolism.

In 2000, Puhringer et al. completed a similar study to the one above. This study utilized a larger sample size and a target-controlled infusion pump. The pump was used to allow for more control of rocuronium administration and to track the volume of the drug with a precise measurement. A controlled open study was conducted utilizing 74 patients. After a standardized

induction, rocuronium 450 micrograms per kilogram was administered. The effects were measured by a single twitch of the adductor pollicis muscle with EMG. The results indicated that although smokers required more rocuronium to stay paralyzed, it was not considered to be statistically significant. Analysis of results completed by a *t*-test demonstrated that dose-requirements, onset time and the spontaneous recovery were not different between smokers and non-smokers. This study appeared to have more control over rocuronium administration then the previous study with the use of the automatic infusion pump, which lead to a more accurate medication administration and recorded volumes. Limitations of the study include that it was not a randomized controlled trial and, although a larger sample size was used, the authors did not address if the results could be generalized to all smokers.

With no new relevant studies completed, a CRNA needs to remember that there is a possibility of an increased metabolism and increased dose requirements when using non-depolarizing muscular blockers in smoking patients. Teiria and Rautoma (1996) found that increased doses of vecuronium and increased volume of distribution were noted in smokers, and this finding appears to be accepted information in the literature even with the mechanism of action unknown. There is a lack of current literature regarding patients who smoke and how this habit interacts with the pharmacokinetics of vecuronium.

Atracurium and cisatricurium are non-depolarizing muscular blockers that are metabolized by Hoffman's elimination. Hoffman's elimination is degradation of the medication by nonspecific esterases at normal pH and temperature. Hoffman's elimination does not include the liver, kidney or cytochrome P450 pathway (Naglehout & Plaus, 2010). Purra, Rorarius, Laippala, and Baer (1998) identified that a patient's smoking may not have an effect on atracurium or cisatricurium if the last cigarette was smoked within three hours of induction.

However, if patients stopped smoking ten hours or more before anesthetic induction there was a potentiation of the block. Purra et al. (1998) hypothesized that smoking leads to the down regulation of receptors, therefore potentiating the neuromuscular block. When a patient has not smoked a cigarette within ten hours of induction, the receptors have not been stimulated, allowing more free receptors available to bind with the neuromuscular blocker. Conversely, those patients who recently smoked will have stimulated their receptors, therefore not altering the dose requirements (Purra et al., 1998). No current literature was found when completing the review, indicating that more research is needed on this topic.

Despite the evidence on pharmacodynamics and pharmacokinetic changes associated with smoking and the impact on opioids and non-depolarizing muscular blockers, it is important for the CRNA to keep in mind that each patient should be treated as an individual case with a unique treatment plan.

Effect of Smoking on Wound Healing

The smoking of cigarettes prolongs wound healing after surgery and complicates the recovery process. Thompsen, Villebro, and Moller (2010) completed a Cochrane Review analyzing randomized controlled trials addressing wound-healing time in patients who continue smoking cigarettes until induction of general anesthesia. Evidence concluded that smokers have increased wound-healing time (Yang & Longaker, 2003) along with an increased risk for infection. Sorenson, Karlsmark and Gottrup (2003) reported that smoking cessation of four weeks improved healing time in patients who had previously smoked.

Sorenson et al. (2003) conducted a randomized controlled trial to determine the ideal smoking cessation time for optimal surgical wound healing. Patients were divided into four groups: smokers who continued to smoke, smokers who quit and received nicotine replacement

therapy in the form of a patch, smokers who quit and received a placebo patch and individuals who had never smoked. Identical wounds of punch biopsies were performed on all patients and assessed after one, four, eight, and twelve weeks. Smoking was continued in all smoking participants until the week before surgery when they were separated into the groups described above. Multiple methods of statistical analysis were completed in accordance with the appropriate data. Sorenson et al. (2003) found, overall, that patients who smoked had an increase in wound infection (12%) compared to the patients who had never smoked (2%).

Sorenson et al. (2003) determined that the patients who continued to smoke throughout the healing process had more infections when assessed at four weeks then those who had quit smoking. No difference in wound healing was noted between the cessation groups receiving NRT and the placebo. The authors believe, due to these results, that NRT in the form of a nicotine patch does not affect wound healing. Limitations of this study include: participants were ASA 1 and 2 with minor comorbidities and medications used. Due to the complexity of patients, it is difficult to isolate smokers who have no other medical history. It is clear from this report that continuing to smoke prior to surgery leads to increased infection and decreased wound healing.

Thompsen et al. (2010) and Yang and Longaker (2003) also completed randomized controlled trials which support Sorensen et al. (2003) and agree that smoking interferes with wound healing and increases the risk of infection. Wong, Lam, Abrishami, Chan, and Chung (2012) completed a systematic review looking at studies identifying the optimal period of cessation for wound healing. Patients who stopped smoking for two weeks prior to surgery showed no improvement in wound healing compared with patients who continued to smoke. Wound healing improved significantly for patients who abstained from smoking for three or

more weeks (Wong et al., 2012). Current literature states that four weeks of smoking cessation prior to a surgical procedure will decrease healing complications.

Perioperative Benefits of Smoking Cessation

Once a person puts out a cigarette and stops smoking the body begins to change physiologically. Within twenty minutes of smoking cessation, blood pressure, heart rate, (Zieve & Dugdale, 2011), blood flow, tissue oxygenation, and metabolism return to normal (Sorenson, 2012). Around eight to twelve hours after cessation, carbon monoxide within the blood stream decreases, more oxygen molecules are able to bind to hemoglobin, and oxygen levels increase (Theadom & Cropley, 2006; Zieve & Dugdale, 2011). After twenty-four hours without a cigarette, oxygen carrying capacity continues to increase (Morgan, 2006) and cardiac complications of spontaneous arrest are decreased (Warner, 2007). Forty-eight hours later, nerves begin to regenerate. This regeneration allows for the growth of the nerve endings, increasing the sense of taste and smell to pre-smoking levels. Three weeks after smoking cessation, blood circulation and lung functions improve after which patients notice decreased coughing and wheezing (Wong et al., 2012). It is at this time that smoking no longer affects platelet function and the clotting cascade normalizes, increasing wound healing (Sorenson, 2012).

The longer a person continues to refrain from smoking, the more benefits are noted. Around one month post-cessation, a surgical patient will have a decreased rate of potential for pneumonia (Theadom & Cropley, 2006). Four weeks of cessation decreases respiratory complications by 23%. The longer the cessation from smoking, the more wound healing improves and wound complications are decreased (Warner, 2007). Sorenson (2012) identified that increased cessation time allowed for circulating endothelial cells to be restored to normal.

Endothelial injury is reduced allowing for the healing process to resume function (Sorenson, 2012).

Lung function improves after continued abstinence. Around six to eight week's after smoking cessation, patients notice a decrease of excess secretions and reduced pulmonary complications (Morgan, 2006). Immune function also improves at this time, as well as overall reduced morbidity (Quraishi, Orkin, & Roizen, 2006). Eight weeks after their last cigarette, a former smoker's pulmonary mechanics have improved significantly so that the respiratory risks are the same as a non-smoker for the application of general anesthesia (Wong et al., 2012). Eight weeks of cessation prior to general anesthesia is optimal to improve outcomes for smoking patients.

It would be ideal for all patients to stop smoking forever; however, smoking is an addiction to a drug that has psychological attachments that makes it difficult for patients to quit. The average smoker who is able to quit permanently will gain six to eight years of life (Warner, 2007), but the complexity of this addiction makes successful cessation attempts difficult. The education of improved overall health and decreased anesthesia risks may help a person decide smoking cessation is worthwhile.

Smoking Cessation Interventions

Current literature regarding smoking cessation education and interventions for a pre-surgical patient is lacking. Before an operation, a patient who is a smoker presents the CRNA an opportunity for a teachable moment. This moment allows the CRNA to influence the patient to make changes to their health that will improve the perioperative experience (Warner, 2007; Wong et al., 2012). Multimodal interventions have been identified as the best approach to assist a patient in long-term smoking cessation.

The pre-operative period is a time when patients are most open to considering lifestyle changes, especially those that may decrease perioperative complications (Quraishi, Orkin, & Roizen, 2006; Theadom & Cropley, 2006). There is little research on smoking cessation interventions; however, the research that is available identifies that education provided in the preanesthesia clinic is more effective and conducive to learning than information provided on the morning of surgery. Recommendations for interventions based on current literature include face-to-face counseling, pharmacotherapy, referral to cessation hotline, telephone counseling, computer assisted counseling and pamphlets addressing reasons to quit (Cropley et al., 2007). Pharmacotherapy may be NRT such as patches, gum, nasal spray, inhalers and lozenges. NRT has been found to be safe in patients with a cardiac history and for use by surgical patients (Cropley et al., 2007). Combinations of counseling, NRT, and support lines were noted to be the most successful when used in the study (Quraishi et al., 2006).

Wong et al. (2012) completed a survey of 177 patients undergoing surgery to determine the education they received on smoking cessation. The patients were asked what type of information they received regarding smoking cessation prior to surgery. They were also asked who from the health care team advised them to stop smoking. Patients were more likely to stop smoking when a surgeon or general practitioner informed them that it was important prior to the procedure. Most cessation attempts acknowledged in the survey were brief rather than long-term. The questionnaire identified that most smokers have a lack of knowledge about the effects smoking has on anesthesia and surgery. Limitations of this study include that it was a retrospective survey, which may lead to a bias in the participants' answers as well as some distortions of the truth. Further limitations exist because the intensity of the advice was not measured, the questions were asked on the day of surgery and no follow up was completed to

determine if those who quit maintained long-term cessation. Wong et al. (2012) recommend that advice on cessation needs to be given, but acknowledge that more research is needed to determine the most effective intervention.

Cropley et al. (2007) completed a review to evaluate the effectiveness of preoperative smoking cessation interventions prior to surgery by examining randomized controlled trials. Combination methods appeared most successful in a majority of the studies compared with one or two interventions. The combination of interventions also produced more results when individualized counseling was included as an intervention. It was not addressed if telephone or computer counseling were counted as individualized counseling. Multimodal interventions were noted to be more helpful in assisting for short-term cessation and that the continuation of support helped to maintain cessation long-term. A limitation of this review was that a meta-analysis was not performed due to a lack of randomized controlled trials. Another limitation includes that interventions could not be compared since the studies used different procedures and follow-up (Webb et al., 2013). Different forms of interventions are required to assist patients in cessation and providing ongoing support encourages long-term abstinence.

Nicotine Replacement Therapy

NRT is an important component of smoking cessation intervention that has been researched, particularly on its effect on surgical outcomes. Thomsen et al. (2010) provided cessation interventions to two randomized groups of breast cancer surgery patients. The first group received one-on-one counseling, NRT free of charge and encouragement to permanently stop smoking after surgery. The second group received perioperative information with no extra education on the importance of smoking cessation. The intervention for the first group was initiated three to seven days before surgery. Patients self-reported cessation, which was

confirmed by exhalation carbon monoxide measurements. After statistical analysis was completed, more patients stopped smoking in the intervention group than the control group from two days before surgery until the ten days after. A twelve-month follow up showed no difference in continued cessation between the two groups. Limitations of the study included: the groups were not randomized, the self-reporting at the twelve-month period was not biochemically confirmed, and the sample size was small. Thomsen et al. (2010) concluded that brief interventions of smoking cessation is not clinically relevant for surgical patients' morbidity and suggests that intervention should occur at least eight weeks prior to a procedure when possible.

Sorenson (2012) completed a systematic review addressing NRT and how it affects wound healing if used as a cessation tool. Currently, NRT is not considered detrimental to postoperative outcomes, as compared with continuing to smoke. Sorenson (2012) found that a transdermal nicotine patch might contribute to lack of an immune response in surgical wounds. The decreased response was believed to affect healing and infection, but the difference noted was not statistically significant. Nicotine's role in wound healing is not completely understood and cannot be determined as detrimental or beneficial in abstinent smokers. At this time, if NRT allows a person to stop smoking, it is less harmful then actually continuing to smoke.

Discussion

Interpretation

Cigarette smoking is common among Americans, therefore CRNAs will frequently encounter patients who smoke and require general anesthesia. When a patient sees a surgeon, they are asking for something to be corrected regarding their health. The initiation of self-care is implied with the willingness to present for surgery. It is important for CRNAs to educate

patients who smoke on the importance of cessation at least eight weeks prior to surgery and to emphasize the benefits of continued abstinence.

Orem's Theory of Self-Care applies to cigarette smoking patients who are scheduled for surgery. These patients are seeking help to improve their health and their lives, and by doing so, they present to CRNAs with a teachable moment. This teachable moment allows for education and support to be provided so that the patient can make an informed decision regarding smoking cessation. Ideally, the benefits of smoking cessation prior to surgery should be discussed with the patient and should include: a reduction of intraoperative complications; a decreased need for pain medications; and improved post-operative wound healing.. Written material should also be provided, along with a support group or hotline and referral for NRT in order to provide a comprehensive approach, which has been proven to be the most successful. Early and complete education theoretically should help a patient decide to attempt smoking cessation in order to allow for some control over the outcome of the surgical procedure.

The evolution of health care has lead to systems where a CRNA will not meet and assess the patient until the morning of surgery. Although beneficial in many aspects, it is a disadvantage to those patients who smoke cigarettes and need education and time to quit smoking. The body begins to change almost immediately after the last cigarette is put out. Within 20 minutes blood pressure, heart rate, blood flow, tissue oxygenation, and metabolism return to normal (Sorenson, 2013). Although the body begins to resume homeostasis, many functions take weeks of cessation to return to pre-smoking function. It takes four weeks of smoking cessation for improved healing of the surgical site in the post-operative period, and eight weeks to reach improved lung function to that of a non-smoker in the intra-operative phase (Sorenson, 2013). The ideal time for a person to stop smoking before an elective procedure

receiving general anesthesia is eight weeks. It would be optimal for a CRNA to meet with a patient that smokes cigarettes at least eight weeks before the procedure to provide comprehensive education and a multimodal cessation strategy to enhance patient safety and decrease perioperative complications.

Even with early education and multimodal support for cessation not every patient will choose to quit. CRNAs will still care for patients who are current smokers and need to consider the physiologic changes that occur in people who smoke cigarettes. Nicotine, the commonly known drug in cigarettes, causes vasoconstriction of the blood vessels which leads to increased heart rate, blood pressure, myocardial excitement and peripheral vascular resistance. As a result, oxygen supply is decreased and demand is increased and systemic oxygenation is decreased (Naglehout & Plaus, 2010). Carbon monoxide is increased in the blood as a result of cigarette smoking, and it also plays a role in decreasing total body oxygenation. Carbon monoxide has an affinity 200 times greater for hemoglobin then does oxygen. Therefore, carbon monoxide will bind to the hemoglobin and decreased the overall oxygen available to the body. The body responds by making more red blood cells, increasing blood viscosity and also the risk for blood clots. All of these factors combined increase a smoker's risk for a myocardial infarction, along with other perioperative complications. Care of a patient who smokes cigarettes should not be altered, but it is important to keep these physiologic changes in mind throughout the perioperative period.

A person who smokes cigarettes may react differently to the medications used to provide general anesthesia. Nicotine causes an initiation of the cytochrome P450 enzyme, which is responsible for the metabolism of many drugs such as opioids and non-depolarizing muscular blockers. Research has concluded that smokers need more opioids for pain control in the post-

operative period (Steinmiller et al., 2012), but is inconclusive on the increased need of rocuronium (Puhringer et al., 2000). Current research is lacking in the area of anesthetic and adjunct medications at this time. It is important for the CRNA to be aware of the possible increased needs for certain medications in patients who smoke cigarettes, yet care for each patient individually.

Dissemination

This project was disseminated during the state NDANA convention on April 19, 2013 to CRNAs and SRNAs within the state of North Dakota. Questions regarding the optimal time of smoking cessation and current research findings were addressed and answered. The information concluded in this project was also disseminated to first year SRNAs at the University of North Dakota in a power-point presentation on May 15, 2013. The presentation included pathophysiology and the implications for practice. Questions about current research finding were addressed. Feedback was positive indicating that the information was presented in a manner which allowed for a different view of anesthesia practice.

Implication for Nursing

Early contact with patients who smoke (which includes education), at least eight weeks prior to an elective procedure, would be ideal for CRNAs. This would allow for an opportunity to allow patients to stop smoking and provide for the best surgical circumstances. Adequate education for patients is essential, as well as education for CRNAs on the importance of discussing and teaching patients about smoking cessation. A policy within the anesthesia department to discuss the importance of smoking cessation and a patient's readiness to quit should be a part of the assessment process, although the morning of surgery is not an appropriate time to stop.

Research

The amount of research on cigarette smoking's effect on anesthesia, post operative wound healing, and teaching methods is sparse. There is a need for increased research in all of these areas. With the recent release of the electronic cigarette is also a cause for more research. Research should address how and if the electronic cigarette fits into cessation plans, if it is an option as NRT, and what affects it may have on general anesthesia. There are many more questions regarding electronic cigarettes that should be addressed in systematic reviews, but as they are still new little research exists.

Conclusion

Patients who smoke cigarettes are a part of the general anesthesia population treated by CRNAs. Smoking cigarettes causes systemic changes to the cardiovascular and respiratory systems. It also adversely affects the metabolism of medications used during general anesthesia and decreases post-operative wound healing. Ideally, a patient should receive education regarding the benefits of smoking cessation prior to general anesthesia. The education should focus on the facts that eight weeks of cessation prior to surgery will help decrease intra-operative risks, as well as the need for pain medication post-operatively (Webb et al, 2013). Education, continued support from health care professionals and NRT are key factors in multimodal cessation programs that help patients quit smoking cigarettes and maintain abstinence.

When a patient presents for a surgical procedure, they are anticipating improving their health. Orem's theory of self-care states when patients are seeking care it is the duty of the nurse to provide the patient with education that will guide them to practice healthy choices. In the instance of patients who smoke, adequate and timely education, along with continued support, is ideal. Hopefully, patients will make the choice to quit smoking at least eight weeks prior to

general anesthesia. These actions will decrease intraoperative risks, decrease post-operative pain medication needs and lead to adequate wound healing with a decreased risk for infection (Sorenson, 2013).

When patients are not able to quit smoking before general anesthesia, it is imperative CRNAs understand the physiologic differences that occur due to the smoking of cigarettes and how these changes affect anesthesia. When a patient undergoing general anesthesia smokes cigarettes it is within the scope of practice for CRNAs to address cessation programs with patients and, in the end, provide a safe anesthetic for these patients whether they are able to quit smoking or not.

References

Adanir, T., Atay, A., Sencan, A., Aksun, M., & Karahan, N. (2010). Effect of cigarette smoking on the washout time of sevoflurane anesthesia. *BMCAnesthesiology, 10:8,* 1-5.

Biggs, A. (2008) Orem's self-care deficit nursing theory: Update on the state of the art and science. *Nursing Science Quarterly, 21*:3, 200-206.

Cropley, M., Theadom, A., Pravettoni, G., & Webb, G. (2007). The effectiveness of smoking cessation interventions prior to surgery: A systematic review. *Nicotine & Tobacco Research, 10,* 407-412.

Mason (2005).*Murray & Nadel's textbook of respiratory medicine* (4th ed). St. Louis MO: Elisevier Saunders.

Morgan, G. E., Mikhail, M. S., & Murray, M. J. (2006). *Clinical anesthesiology* (4th ed.). New York, NY: McGraw-Hill.

Nagelhout, J. L. & Plaus, K. L. (2010). *Nurse anesthesia,* (4th ed.). St. Louis, MO: Elsevier Saunders.

Orem, D.E. (1991). *Nursing: Concepts of practice* (4th ed.). St. Louis, MO: Mosby-Year Book Inc.

Puhringer, F. K., Keller, P., Lockinger, A., Kleinsasser, A., Scheller, A., Raedler, C., & Keller, C. (2000). Smoking does not alter the dose-requirements and the pharmacodynamics of rocuronium. *Canadian Journal of Anesthesia, 47:*4, 347-349.

Puura, A. I. E., Rorarius, M. G. F., Laippala, P., & Baer, G. A. (1998). Does abstinence from smoking or a transdermal nicotine system influence Atracurium-induced neuromuscular block? *Anesthsia Analgesia, 87,* 430-433.

Quraishi, S. A., Orkin, F. K., & Roizen, M. F. (2006). The anesthesia preoperativeassessment: An opportunity for smoking cessation intervention. *Journal of Clinical Anesthesia, 18,* 635-640.

Rautoma, P., & Svartling, N. (1998). Smoking increases the requirement for rocuronium. *Canadian Journal of Anesthesia 45:7,* 651-654.

Rodrigo, C. (2000). The effect of cigarette smoking on anesthesia. *Anesthesia Progress, 47,* 143-150.

Saha, U. (2009). Tobacco interventions and anesthesia: A review. *Indian Journal of Anaesthesia, 53,* 618-627.

Sorensen, L. T. (2012). Wound healing and infection in surgery: The pathophysiological impact of smoking, smoking cessation and nicotine replacement therapy a systematic review. *Annals of Surgery, 255:6,* 1069-1079.

Sorensen, L. T., Jorgensen, S., Petersen, L. J., Hemmingsen, U., Bulow, J., Loft, S., Gottrum, F. (2009). Acute effect of nicotine and smoking on blood flow, tissue oxygen, and aerobe metabolism of the skin and subcutis. *Journal of Surgical Research, 152,* 224-230.

Sorenson, L. T., Karlsmark, T., Gottrum, F. (2003). Abstinence from smoking reduces incisional wound infection: A randomized controlled trial. *Annals of Surgery. 238,* 1-5.

Steinmiller, C. L., Diederichs, C., Roehrs, T. A., Hyde-Nolan, M., Roth, T., & Greenwald, M.K. (2012). Postsurgical patient-controlled opioid self-administration is greater in hospitalized abstinent smokers than nonsmokers. *Journal of Opioid Management, 8:4,* 227-235.

Sweeney, B. P. & Graylin, M. (2009). Smoking and anaesthesia: The pharmacological implications. *Journal of the Association of Anaeshetists of Great Britain and Ireland, 64,* 179-186.

Teiria, H., Rautoma, P., & Yli-Hankala, A. (1996). Effects of smoking on dose requirements for vecuronium. *British Journal of Anaesthesia, 76,* 154-155.

Theadom, A., & Cropley, M. (2006). Effects of preoperative smoking cessation on the incidence and risk of intraoperative and postoperative complication in adult smokers: A systematic review. *Tobacco Control, 15,* 352-358.

Thomsen, T., Tonnesen, H., Okholm, M., Kroman, N., Maibom, A., Sauerberg, M., & Moller, A.M. (2010). Brief smoking cessation intervention in relation to breast cancer surgery: A randomized controlled trial. *Nicotine & Tobacco Research, 12,*1118-1124.

Tomey, A.M., & Alligood, M.R. (2006). *Nursing theorists and their work* (6th ed.). St. Louis MO: Mosby Elsevier.

Warner, D. O. (2007). Tobacco dependence in surgical patients. *Anesthesia and medical disease, 20*, 279-283.

Webb, A. R., Robertson, N., Sparrow, M. (2013). Smokers know little of their increased surgical risks and may quit on surgical advice. *ANZ Journal of Surgery.* doi: 10.1111/ans.12096

Wong, J., Lam, D. P., Abrishami, A., Chan, M. T. V., & Chung, F. (2012). Short-term preoperative smoking cessation and postoperative complications: A systematic review and meta-analysis. *Canadian Journal of Anesthesia, 59,* 268-279.

Yang, G. P., & Longaker, M. T. (2003). Abstinence from smoking reduces incisional wound infection: A randomized controlled trial. *Annals of Surgery. 238,* 6-8.

Zieve, D., & Dugdale, D. C. (2011). Benefits of quitting tobacco. In *MedlinePlus Medical Encyclopedia.* Retrieved from http://www.nlm.nih.gov/medlineplus/ency/article/007532.htm

Appendix A

UNIVERSITY OF NORTH DAKOTA

General Anesthesia and the Importance of Smoking Cessation

Katie Pence, SRNA

Introduction & Statement of Problem

- Approximately 23% of adults in the US smoke cigarettes (Nagelhout & Plaus, 2010).
- Cigarettes smoking adversely affects the perioperative period
  - Increased need for analgesia
  - Potential increased need for non-depolarizing neuromuscular blockers
  - Decreased wound healing
  - Increased risk of infection

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Purpose

- Review the patho-physiologic effects of cigarette smoking and determine it's impact on general anesthesia
- Identify the ideal time frame for smoking cessation prior to general anesthesia
- Disseminate the information to CRNAs and SRNAs, stressing the importance of smoking cessation for their patients prior to general anesthesia

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Significance

- By 2025 it is thought that 1.5 billion people will be smoking world wide (Saha, 2009)
- Smoking adversely affects the cardiovascular and respiratory systems, impacts infection and delays wound healing
- Smokers may have an increased requirement for anesthetic drugs and adjunct drugs

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Research Questions

- What effect does cigarette smoking have on the perioperative period?
- What is the optimum smoking cessation time to decrease perioperative morbidity?
- What is the most effective way to educate smokers on the importance of smoking cessation prior to general anesthesia?

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Framework

- Orem's Self-Care Theory
  - Self-care deficit occurs when a person needs help or support to maintain self-care
  - Education is utilized to enhance healthy behaviors
  - Providing support, along with knowledge, empowers the patient to choose cessation of smoking to decrease perioperative complications

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Overview of Methods

- Electronic literature review utilizing Cochrane Reviews and the Harley French Library
- Harley French Online Library was used to access search engines including PubMed and CINAHL
  - Once articles were identified as pertinent, similar articles were reviewed for pertinence

Results: Cardiovascular Effects

- Nicotine stimulates vasoconstriction
  - Increased HR, BP, PVR
  - Decreased coronary blood flow
    - Increases demand of O2 with a decreased supply
  - Increased oxygen via workload of the heart
  - Carbon monoxide increased in bloodstream
    - CO attaches to hemoglobin where O2 should attach, decreased O2 is available -> oxyhemoglobin shift left
    - RBC's increased production increasing viscosity of blood, leading risk of clotting (Nagelhout & Plaus, 2010)

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Results: Respiratory Effects

- Toxic chemicals cause difficulty clearing airway
  - Cilia are destroyed
  - Mucous becomes thicker
- Constriction of airways occurs
  - Compromises surfactant production
  - Further complicating alveoli integrity (Rodrigo, 2000)

Results: Pharmacokinetic and Pharmacodynamics Changes

- Nicotine stimulates ganglionic effects, similar to acetylcholine
- Stimulates cholinergic receptors
  - Adrenal Glands
    - Adrenalin
    - Noradrenaline
    - Dopamine
    - Endorphins
- Leading to addictive qualities

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Results: Pharmacokinetic and Pharmacodynamics Changes

- Polycystic Aromatic Hydrocarbons
  - Carcinogenic substances produced from cigarette smoking that disrupts Cytochrome P450 pathway
- Smoking induces enzyme
  - Medications bind faster and therefore metabolize quicker

Results: Pharmacokinetic and Pharmacodynamics Changes

- Volatile anesthetics are not metabolized by Phase I metabolism
  - Sevoflurane washout time is similar in patients who smoke cigarettes and those who never have (Adanir et al., 2010)
- Non-depolarizing neuromuscular blockers
  - Vecuronium: increased need in smokers (Tierea et al. 1996)
  - Rocuronium remains controversial (Rautoma & Svartling, 1998) (Puhringer et al, 2000)

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Results: Wound Healing

- Smoking cigarettes leads to a wound healing deficit
  - Vasoconstriction and decreased oxygenation to area increase healing time of surgical wounds (Sorenson, 2012)
  - Sorenson (2012) found nicotine replacement therapy does not reduce healing
- Four weeks cessation is recommended to decrease risk of infection and improve healing (Warner, 2007)

Pre-Operative Teaching

- Cessation of smoking 8 weeks preoperatively improves respiratory function significantly, decreasing perioperative complications under general anesthesia (Wong, Lam, Abrishami, Chan, & Chung, 2012)
- Multimodal teaching strategies including
  - Verbal education
  - Nicotine replacement therapy
  - Personalized counseling
  - Continued support (Webb, Roberson & Sparrow, 2013).

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Results

- Patients scheduled for general anesthesia are not receiving important education on the importance of smoking cessation (Theadom & Cropley, 2006)
- Patients need appropriate and timely education so they can practice self-care and play an active role in their surgical experience
- An early initial visit with patients including follow-up support and brochures would be ideal to provide optimal outcomes

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

References

Adamir, T., Atay, A., Sencan, A., Aksun, M., & Karahan, N. (2010). *BMC Anesthesiology, 10:8.*

Cropley, M., Theadom, A., Pravettoni, G., & Webb, G. (2007). The effectiveness of smoking cessation interventions prior to surgery: A systematic review. *Nicotine &Tobacco Research, 10,* 407-412.

Mason Murray &Nadel's textbook of respiratory medicine. (4th ed). (2005). Elisevier Saunders.

Morgan, G.E., Mikhail, M.S., & Murray, M.J. (2006). *Clinical anesthesiology,* (4th ed.).New York, NY: McGraw-Hill.

Nagelhout, J.L. & Plaus, K.L. (2010). *Nurse anesthesia.* (4th ed.). St. Louis, MO: Elsevier Saunders.

Puhringer, F. K., Keller, P., Lockinger, A., Kleinsasser, A., Scheller, A., Raedler, C., & Keller, C (2000). Smoking does not alter the dose-requirements and the pharmacodynamics of rocuronium. *Canadian Journal of Anesthesia, 47:4,* 347 349.

Puura, A. I. E., Rorarius, M. G. F., Laippala, P., & Baer, G.A. (1998). Does abstinence from smoking or a transdermal nicotine system influence Atracurium-induced neuromuscular block? *Anesthsia Analgesia, 87,* 430-433.

Quraishi, S. A., Orkin, F. K., & Roizen, M. F. (2006). The anesthesia preoperativeassessment: an opportunity for smoking cessation intervention. *Journal of Clinical Anesthesia, 18,* 635-640.

Rautoma, P., & Svartling, N. (1998). Smoking increases the requirement for rocuronium.*Canadian Journal of Anesthesia 45:7.* 651-654.

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

References

Rodrigo, C. (2000). The effect of cigarette smoking on anesthesia. *Anesth Prog, 47,* 143-150.

Saha, U. (2009). Tobacco Interventions and Anesthesia- A review. *Indian Journal of Anaesthesia, 53:* 618-627.

Sorensen, L.T. (2012). Wound healing and infection in surgery: The pathophysiologicalimpact of smoking, smoking cessation and nicotine replacement therapy asystematic review. *Annals of Surgery, 255:6,* 1069-1079.

Sorensen, L.T., Jorgensen, S., Petersen, L.J., Hemmingsen, U., Bulow, J., Loft, S.,Gottrum, F. (2009). Acute effect of nicotine and smoking on blood flow, tissueoxygen, and aerobe metabolism of the skin and subcutis. *Journal of Surgical Research, 152,* 224-230.

Sorenson, L.T., Karlsmark, T., Gottrum, F. (2003). Abstinence from smoking reduces incisional wound infection: A randomized controlled trial. *Annals of Surgery 238,* 1-5.

Steinmiller, C. L., Diedenchs, C., Roehrs, T.A., Hyde-Nolan, M., Roth, T., & Greenwald M.K. (2012). Postsurgical patient-controlled opioid self-administration is greater in hospitalized abstinent smokers than nonsmokers. *Journal of OpioidManagement, 8:4,* 227-235.

Sweeney, B.P. & Graytin, M. (2000). Smoking ad anaesthesia: the pharmacological implications. *Journal of the Association of Anaesthetists of Great Britain and Ireland, 64,* 179-186.

Teria, H., Rautoma, P., & Yli-Hankala, A. (1996). Effects of smoking on dose requirements for vecuronium. *British Journal of Anaesthesia, 76,* 154-155.

Theadom, A., & Cropley, M. (2006). Effects of preoperative smoking cessation on the incidence and risk of intraoperative and postoperative complication in adult smokers: a systematic review. *Tobacco Control, 15,* 352-358.

Thomsen, T., Tonnesen, H., Okholm, M., Kroman, N., Maibom, A., Sauerberg, M., & Moller, A.M. (2010). Brief smoking cessation intervention in relation to breast cancer surgery: A randomized controlled trial. *Nicotine & Tobacco Research, 12,*1118-1124.

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

References

Torney, A.M., & Allgood, M.R. (2006). *Nursing theorists and their work* (5th ed.). St.Louis MO: Mosby Elsevier.

Warner, D. O. (2007). Tobacco dependence in surgical patients. *Anesthesia and medical disease, 20,* 279-283.

Webb, A.R. Robertson, N., Sparrow, M. (2013). Smokers know little of their increased surgical risks and may quit on surgical advice. *ANZ Journal of Surgery.*

Wong, J., Lam, D.P., Abrishami, A., Chan, M.T.V., & Chung, F. (2012). Short-term preoperative smoking cessation and postoperative complications: a systematic review and meta-analysis. *Canadian Journal of Anesthesia, 59,* 268-279.

Yang, G.P., Longaker, M.T. (2003). Abstinence from smoking reduces incisional wound infection: A randomized controlled trial. *Annals of Surgery, 238,* 6-8.

CREATIVE INNOVATIVE ENTREPRENEURIAL SPIRITED UND THE UNIVERSITY OF NORTH DAKOTA

Thank You
Are There Any Questions?

Appendix B

The Effects of Cigarette Smoking on General Anesthesia

Katie Pence, SRNA
University of North Dakota

Objectives

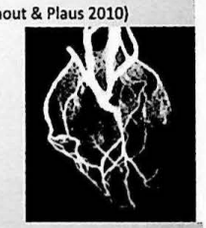
- Review the pathophysiology of cigarette smoking
- Discuss the pharmacokinetics and pharmacodynamics of common drugs used in general anesthesia on patients who smoke
- Discuss the effects smoking has on post-operative wound healing
- Review the changes that occur in the body once a person quits
- Discuss the effective teaching strategies to encourage patients to quit smoking at least 8 week prior to a surgical procedure

Smoking and Anesthesia

- 23% of Americans Smoke Cigarettes
- People who smoke live 14 years less
- Only 58% of surgeons and 32% of CRNA's provided patients with smoking cessation information (Rodrigo, 2000)

Cardiovascular Effects

- Nicotine
  - Vasoconstriction
  - Increased BP, PVR, and myocardial excitement
- Decreased coronary blood flow
  - Increased demand of oxygen (Nagelhout & Plaus 2010)



Oxygenation

- Increased oxygen consumption in smokers
- Increased Carbon Monoxide
  - Hemoglobin's affinity for CO is _____> than O2
  - Decreased amount of O2 available to tissue
  - Oxyhemoglobin shift to _____?

Oxygenation Continued

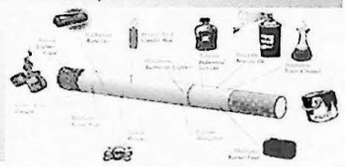
- Increased demand of oxygen by the tissues leads to increased production of RBC's
- Increase in RBC's increases blood viscosity
  - Increasing risk for clot

Respiratory Effects

- Cigarette smoking releases toxic chemicals
  - Destroy cilia
  - Mucosa becomes thicker
  - Difficulty clearing the airway
  - Airway constriction
  - Smaller alveoli are compromised, decreasing ability to make surfactant

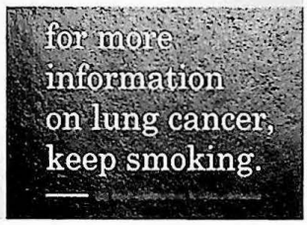
Nicotine

- Acts similar to ACh by stimulating ganglionic effects
- Adrenal Glands are stimulated to release
  - Adrenalin
  - Noradrenaline
  - Dopamine- thought to be responsible for addictive qualities
  - Endorphins



Long term effects:

- COPD (chronic obstructive pulmonary disease)
- Heart Disease
- Cancers (including but not limited to:)
  - Lung
  - Kidney
  - Cervix
  - Bone Marrow



Our favorite enzyme

- Smoking cigarettes releases polycystic aromatic hydrocarbons (PAH)
  - Carcinogenic substances that disrupt Cytochrome P450 pathway
- Induction of CP450

Cytochrome P450

- Liver enzyme
- Part of Phase I metabolism
- When induces increases metabolism of some drugs
  - Many of the drugs that work on CNS
    - Neuromuscular blockers
    - Opioids
    - Sedatives

Volatile Anesthetics ?

- Metabolized by CP450, but not Phase I
- Sevoflurane washout time is similar in patients who smoke cigarettes and those who never have (Adanir et al., 2010)
- Lack of research on the effect of volatile anesthetics and people who smoke cigarettes

Opioids

- People who smoke have an increased need of opioids post-operatively
- Smokers used and requested more opioids in PACU and first 24 hours than did non-smokers (Steinmiller, et al. 2012)
- Lack of research on the use of opioids during intraoperative period

NDMB

- 1996 Tiera et al. determined that **vecuronium** was needed at increased doses in smoking patients
- **Rocuronium**
  - Remains controversial
  - (Rautoma & Svartling, 1998)
  - (Puhringer et al, 2000)

Atricurium & Cisatricurium

- Eliminated by Hoffman's elimination
- Last cigarette within 3 hour -> no change in elimination time
- Last cigarette in more then 10 hours of general anesthesia= potentiation of block (Purra et al. 1998)

Wound Healing

- Wound healing is delayed in people who smoke
  - Vasoconstriction decreased blood flow to the area
  - CO causing a shift to the left of the oxyhemoglobin dissociation curve (Sorenson, 2012)

Put it out.....

- **20 minutes**: HR and BP return to normal
- **8-12 hours:** CO decreased, allowing O2 to bind to hemoglobin, increasing systemic oxygenation (Theadom & Cropley, 2006)
- **24 hours:** a significant decrease in cardiac complication (Warner, 2007)
  - Especially sudden heart attack
- **48 hours:** nerves begin to regenerate
  - Restoring sense of smell and taste (Wong, Lam, Abrishami, Chan, & Chung, 2012)

Cessation Changes

- **2-3 weeks:**
  - Circulation continues to improve
  - Clotting returns to normal
  - Improved lung function
- **4 weeks:**
  - Wound healing improves
    - Circulating endothelial cells are restored, reducing endothelial injury and allowing the healing process to function appropriately (Sorenson, 2012)

Conclusion

- Patients scheduled for general anesthesia are not receiving education on the importance of smoking cessation (Theadom & Cropley, 2006)
- Patients need appropriate and timely education so they can practice self-care and play an active role in their surgical experience
- An early initial visit with patients including follow-up support and brochures would be ideal to provide optimal outcomes

References

Adanir, T., Atay, A., Sancan, A., Aksun, M., & Karahan, N. (2010). *BMC Anesthesiology, 10:8.*

Cropley, M., Theadom, A., Pravettoni, G., & Webb, C. (2007). The effectiveness of smoking cessation interventions prior to surgery. A systematic review. *Nicotine &Tobacco Research, 10,* 407-412.

Mason: Murray &Nadel's textbook of respiratory medicine. (4th ed). (2005). Elsevier Saunders.

Morgan, G.E., Mikhail, M.S., & Murray, M.J. (2006). *Clinical anesthesiology,* (4th ed.) New York, NY: McGraw-Hill.

Nagelhout, J.L. & Plaus, K.L. (2010). *Nurse anesthesia.* (4th ed.). St. Louis, MO: Elsevier Saunders.

Puhringer, F. K., Keller, P., Lockinger, A., Kleinsasser, A., Scheller, A., Raedler, C., & Keller, C (2000). Smoking does not alter the dose-requirements and the pharmacodynamics of rocuronium. *Canadian Journal of Anesthesia, 47:4,* 347 349.

Puura, A. I. E., Rorarius, M. G. F., Laippala, P., & Baer, G.A. (1998). Does abstinence from smoking or a transdermal nicotine system influence Atracurium-induced neuromuscular block? *Anesthsia Analgesia, 87,* 430-433.

Qumaishi, S. A., Orkin, F. K., & Roizen, M. F. (2006). The anesthesia preoperative assessment: an opportunity for smoking cessation intervention. *Journal of Clinical Anesthesia, 18,* 635-640.

Rautoma, P., & Svartling, N. (1998). Smoking increases the requirement for rocuronium.*Canadian Journal of Anesthesia 45:7,* 651-654

References

Tomey, A.M., & Alligood, M.R. (2006). *Nursing theorists and their work* (6th ed.). St.Louis MO: Mosby Elsevier.

Warner, D. O. (2007). Tobacco dependence in surgical patients. *Anesthesia and medical disease,* 20, 279-283.

Webb, A.R. Robertson, N., Sparrow, M. (2013). Smokers know little of their increased surgical risks and may quit on surgical advice. *ANZ Journal of Surgery.*

Wong, J., Lam, D. P., Abrishami, A., Chan, M.T.V., & Chung, F. (2012). Short-term preoperative smoking cessation and postoperative complications: a systematic review and meta-analysis. *Canadian Journal of Anesthesia, 59,* 268-279.

Yang, G. P., Longaker, M. T. (2003). Abstinence from smoking reduces incisional wound infection: A randomized controlled trial. *Annals of Surgery. 238*

References

Rodrigo, C. (2004). The effect of cigarette smoking on anesthesia. *Anesth Prog, 47,* 143-150.

Salte, U. (2009). Tobacco interventions and Anesthesia- A review. *Indian Journal of Anaesthesia, 53:* 618-627.

Sorensen, L.T. (2012). Wound healing and infection in surgery: The pathophysiologicalimpact of smoking, smoking cessation and nicotine replacement therapy asystematic review. *Annals of Surgery, 255:6,* 1069-1079.

Sorensen, L.T., Jorgensen, S., Petersen, L.J., Hemmingsen, U., Bulow, J., Loft, S.,Gottrum, F. (2009). Acute effect of nicotine and smoking on blood flow, tissueoxygen, and aerobe metabolism of the skin and subcutis. *Journal of Surgical Research, 152,* 224-230.

Sorensen, L.T., Karlsmark, T., Gottrum, F. (2003). Abstinence from smoking reduces incisional wound infection: A randomized controlled trial. *Annals of Surgery.238,* 1-5.

Steinmiller, C. L., Diedericks, C., Rosins, T.A., Hyde-Nolan, M., Roth, T., & Greenwald,M.K. (2012). Postsurgical patient-controlled opioid self-administration is greater in hospitalized abstinent smokers than nonsmokers. *Journal of OpioidManagement, 8:4,* 227-235.

Sweeney, B.P. & Grayling, M. (2009). Smoking ad anaesthesia: the pharmacological implications. *Journal of the Association of Anaesthetists of Great Britain and Ireland, 64,* 179-186.

Teiria, H., Rautoma, P., & Yli-Hankala, A. (1996). Effects of smoking on dose requirements for vecuronium. *British Journal of Anaesthesia, 76,* 154-155.

Theadom, A., & Cropley, M. (2006). Effects of preoperative smoking cessation on the incidence and risk of intraoperative and postoperative complication in adult smokers: a systematic review. *Tobacco Control, 15,* 352-358.

Thomsen, T., Tonnesen, H., Okholm, M., Kroman, N., Maibom, A., Sauerberg, M., & Moller, A.M. (2010). Brief smoking cessation intervention in relation to breast cancer surgery: A randomized controlled trial. *Nicotine & Tobacco Research, 12,*1118-1124.

Thank you
Any Questions?