Improving Smoke Control in Operating Rooms with Smoke Evacuators

Inez Edmondson

A Directed Scholarly Project Submitted to the
Department of Nursing
In the Graduate School of
Bradley University in
Partial fulfillment of
The requirements for the
Degree of Doctor of Nursing Practice.

Peoria, Illinois

2020

Acknowledgments

I would like to thank Dr. Melissa Katsetos- Hensley, for her commitment to working with me as my project mentor. Her sense of guidance, support, and leadership style have been invaluable to me. Dr. Hensley has a unique ability to mentor and communicate with people as she serves as a role model. Dr. Katsetos-Hensley has been a constant source of encouragement; one could not ask for a more loyal mentor. I am blessed to know someone like her. A special thanks to the Director of the Orthopedic Surgery Center for using the facility as a project site. Thanks to the team and all of the staff for participating and supporting my project.

Abstract

Electrocautery surgical procedures are performed frequently in the United States. The exposure of smoke generated from surgical energy-based instruments such as the electrocautery, laser tissue ablation, and ultrasonic scalpel tissue dissection during surgery produce high levels of toxic, hazardous smoke, putting operating room (OR) personnel at a dangerous health risk. These instruments cauterize vessels and destroy tissue, and the fluid and blood produce gaseous material known as a smoke plume. There is a direct relationship during electrocauterization surgery between carbon monoxide released in the air and OR personnel experiencing nausea and headaches. Historically, air conditioning systems and natural face masks were believed to protect OR personnel from the dangerous smoke contaminate in the OR air. Currently, research has determined these items are not enough to shield and protect OR personnel from the smoke contaminated environment. There have been complaints of headaches, nasal drip, nausea, burning eyes, and colds lingering for an extended period of time. These symptoms are rarely reported to employee health. (Bree et al., 2017; Fencil, 2017; Wang et al., 2015; Shultz, 2014). Current wall suction evacuation systems used in ORs do not have adequate airflow to capture the smoke plume. Previously, researchers suggested that only team members at the direct surgical site were exposed. However, new research has proven that all members of the surgical team within the OR are exposed to a similar level of surgical smoke (Watson, 2015; York & Autry, 2018). The purpose of this project is to control smoke in the ORs, with a smoke evacuation system (SES) that can capture smoke plume efficiently to improve air quality.

Smoke exposure is a health hazard for OR personnel. Surgical smoke contents are described as being toxic. The primary concern is that smoke plume will continue if electrocauterization devices are used and will continue to expose OR personnel to smoke hazards (Watson, 2015).

Surgery Smoke Plume, Health Hazards, Smoke Evacuation System, Operating Room Experience

Table of Contents

Chapter I: Introduction

A clean air environment in the operating room (OR) is currently a challenge to achieve but requires new technology to eliminate health risks smoke imposes on OR personnel. The purpose of this project is to use existing technology to reduce the smoke-related health risk created using electrocautery devices during surgical procedures in the ORs. Surgical smoke can be the primary source of health problems for OR personnel and may ultimately lead to more severe health risks if not addressed (Fencil, 2017). Nausea, headaches, and burning eyes was this author's experience as an OR circulator, and all contributed to continuing health concerns as a result of smoke contaminants during surgery in the OR. Smoke contaminants create an unsafe working environment and must address and corrected to become a safe working environment.

The smoke-contaminated environment requires new technology to reduce or eliminate levels to improve air quality in ORs during electrocautery surgery. The project objective is to introduce smoke evacuator systems, which is existing technology, to the ORs at the project site location, to reduce smoke while improving air quality in ORs. Air quality is the degree to which air is suitable or clean enough for humans, animals, or plants to live and remain healthy (Dictionary, n.d.). An air quality index (AQI) utilized to communicate just how polluted the air currently is or how polluted it is forecasted to become (AQI, n.d.).

Concerns about surgical smoke reported over the past thirty years. Interprofessional professional indifference is the source for surgeons, and the surgical team underlines indifference that continues the smoke effect problems. Smoke hazards have been identified but are easier to convey to people as safety hazards rather than health hazards because it takes time to create and develop a strategy to address smoke hazards (Fencil, 2017). The topic of surgical smoke is broad; therefore, this project will focus specifically on the effects of poor air quality on individuals repeatedly exposed to toxic smoke plume in their roles as OR personnel. The project is classified as Quality Improvement (QI), which will focus on controlling the smoke in ORs, with a smoke

evacuation system (SES) that can capture the smoke efficiently to improve air quality during an electrocautery surgery.

Background and Significance

There is over 500,000 personnel working in ORs, reported by the Occupational Safety and Health Administration (OSHA, n. d.), in the United States who potentially exposed to surgical smoke. Surgical smoke is the primary source placing OR workers in an unhealthy environment producing negative health effects such as nausea, burning eyes, running nose, pulmonary irritation, and inflammation (Lee et al., 2018; Okoshi et al., 2015; York & Autry, 2018).

There are existing regulations concerning smoke plume in the hospital ORs. However, the wording in the regulations is generic. When examining standards that exist to protect other workers exposed to smoke in their work environment, for example, welders, it found that their regulations have more detail and specific language that does not produce uncertainty (York & Autry, 2018). Governing bodies that oversee medical organizations appear to use passive language in regulations with words like *recommended, encouraged,* and *suggested.* Consequently, there is no sound direction in the regulations. There is a significant need for regulatory bodies to implement specific standards that provide strong language and support (York & Autry, 2018). Additionally, there is a need for harsher oversite creating a smoke-free environment in the OR. This project addresses the health risk problem by implementing a Smoke evacuator system. (York & Autry, 2018).

The use of electrocauterization instruments in the OR produces smoke that is the source of health risks to OR personnel. Smoke generated from the electrocautery devices (for cutting tissue), lasers (for tissue ablation), and ultrasonic scalpel (for tissue dissection) produces a hazardous smoke plume that compared to health risks associated with cigarette smoking (Fencil, 2017). Smoke plume occurs in the hospital ORs due to the electrocautery device was developed in 1926 (Bree, Barnhill, & Rundell, 2017; Fencil, 2017). This device is an energy-based

electrocautery instrument containing a heating element that creates a smoke plume when it contacts human tissue. This device creates incisions and clots the blood during surgical procedures. The energy device design concept is the mechanism used in many of today's instruments like lasers, electrocautery scalpels, and pens (Bree et al., 2017). The electrocautery device method allows the surgical team to perform electrosurgical procedures, such as ablation and cutting of body tissue, while limiting the depth of necrosis and limiting damage to nearby sites (Eggers & Thapllyal, 1998).

There is a direct relationship during electrocauterization surgery between the carbon monoxide released in the air and OR personnel experiencing nausea and headaches. The smoke aerosolize tissue irritates the lungs having similar mutagenic effects to smoking 27 to 30 cigarettes daily (Bree, Barnhill, Rundell, 2017; Fencil, 2017; Okoshi et al., 2015). The operating rooms using electrocautery surgery, share these common health risks by using these devices daily.

Currently, air conditioning systems and natural face masks are assumed to protect OR Staff from the dangerous smoke contaminants in the OR air. Current research has determined these items are not enough to shield OR personnel (Bree et al., 2017; Fencil, 2017; Manson & Damrose, 2013; Shultz, 2014; Wang et al., 2015). There are emerging technologies to improve the quality of air in the OR by eliminating smoke plume. The smoke evacuator system (SES) technology is used to improve air quality by removing as much of the smoke plume as possible (Bree et al., 2017; Fencil, 2017; Shultz, 2014; Wang et al., 2015;). Not until 1985 was cauterization technology classified as a health hazard by the National Institute for Occupational Safety and Health (NIOSH). (Okoshi et al. 2015)

To be consistent throughout the paper, describing the type of surgery action similar to cutting, coagulation, and fulguration will be referred to as electrocautery. The term surgical smoke will define both visible and microscopic smoke (Bree et al., 2017; Okoshi et al., 2015). During the cauterization of tissues, the release of cellular fluid creates a smoke plume. Chemical

constituents of the smoke plume are 95% water vapor, and the remaining 5% are cellular fragments made up of chemical toxins that produce negative health effects (Bree et al., 2017; Watson, 2015). Smoke constituents and particle size determine how the smoke deposited in the human respiratory system. Particle sizes of 5 microns are deposited in the upper airway, and < 2 microns deposited in the bronchioles and the alveoli (Choi et al., 2014; Okoshi et al., 2015; Watson, 2015; Fencil, 2017).

Equally important are speeds and distance, which particles travel. Particle concentration can increase from baseline of about 60,000 particles per cubic foot to approximately a million particles per cubic foot within five minutes after the electrosurgery unit (ESU) is active and remain elevated throughout the use of the ESU (Watson, 2015). In the past, researchers suggested that only team members at the direct surgery site were exposed. However, research has since proven that all members of the surgical team within the surgery area exposed to a similar level of surgical smoke (Watson, 2015; York & Autry, 2018). The statement conveys the need for implementation of a smoke evacuator system to improve air quality in ORs during electrocautery surgery.

Professional organizations and government agencies addressing surgical smoke have recommended local exhaust ventilation (LEV) (Okoshi et al., 2015). The following professional organizations support the recommendations: Association of Pre-Operative Registered Nurses (AORN), The American National Standard Institute (ANSI), Occupational Safety & Health Administration (OSHA), NIOSH, and the Centers for Disease Control (CDC) (Okoshi et al., 2015).

Regulatory organizations such as the Joint Commission Accreditation of Healthcare Organizations (JCAHO) created recommendations for hospitals to identifying energy-based devices (lasers) and instructing the hospital organizations to act to minimize the risks of exposing personnel to surgical smoke (Harkavy & Novak, 2014). Several recommendations have been

created by JCAHO and NIOSH that directly address the capturing of smoke and preventing smoke escape into the ORs. Other recommendations suggest hospitals reduce the risk of smoke affecting OR personnel by using a special respiratory protection device. While several surveys and questionnaires used to educate OR personnel on the health effects associated with smoke plume, there must be greater emphasis on following regulatory standards, and it must be done with integrity. (Harvay & Novak, 2014; Steege, Boiano, & Sweeney, 2016; Shultz, 2014).

Needs assessment

To assess needs a Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis performed at the project site to evaluate a-needs assessment. The strength of the organization lies in its reputation for being a quality sports orthopedic surgery center located in the southwest Ohio tri-state area. Every type of orthopedic injury, whether requiring surgery or not, can be managed at the center. The center has a full supporting staff of surgeons, nurses, physical therapists, and caregivers to support all of the patients' needs. Collaboration is a strong attribute for the project site. First, the collaboration with nearby major universities sports medicine departments developing techniques to improve patient outcomes. Secondly, the collaboration with special medical groups focusing on areas of health wellness for men, women, and children. Thirdly, the project site has management support for creating clean air facilities.

Three identified weaknesses are significant to internal factors of the project site: stakeholder interest, surgical team indifference, and generic health regulations. Understanding the depth of services that a surgery center provides, a funding request is an incredibly competitive process. Stakeholders have extreme demands for specific funding programs that fit unique services. This environment leads to scrutiny of any type of funding for improvement programs. The inter-professional indifference among team members provides an opportunity for negative indifference and communication affecting teamwork. Team members supporting different surgeries may feel

particular improvement programs are more critical than others, which in turn may affect team cohesion. The center's health regulations are very generic and conveyed in a passive voice.

There are several external opportunities and threat factors for the project site; technology development, and quality improvements to the facility adopting the use of SES are all excellent opportunities. Another opportunity is to influence legislation for a smoke-free environment in operating rooms in addition to the expansion of medical collaboration into rural areas where no collaboration currently exists. Several external threats are affecting this project site. One major threat when Doctors/Surgeons resist the use of smoke evacuators when performing electrocautery surgery. Not only denying the use of a device that reduces smoke contaminants in the OR, but this competition between surgery facilities. A second threat is the negotiation process to obtain action can lead to other surgery facilities not using smoke evacuators producing strong funding for specific projects. And thirdly, there is a threat to obtain the major stakeholder's support to push the project through the process. The mission of the project site is to improve medicine and procedures for better health and wellness for all of their patients and employees.

Problem Statement

The exposure of smoke plume is a health hazard for OR personnel. The contents of surgical smoke are described as toxic. The concern is smoke plume will continue as long as using electrocauterization devices without a smoke evacuator system to control the smoke. And the OR personnel will continue to be exposed to toxic smoke plume (Watson, 2015).

Project Purposes/Aims; Objectives

This project aims to identify the best possible resources to reduce exposure of operating room personnel and the patient population from toxic surgery smoke plume. I am introducing existing technology in the ORs, which can reduce smoke plume and improve air quality.

During week one, the project consists of examining the research literature and identify smoke plume contaminants' health effects on OR staff, during electrocautery surgery. Document

the smoke contaminants as it is related to health risk to staff. Review the evidence-based practice with the institution mentor and health & environmental Safety officer.

During week two, evaluate the configuration of the operating room to identify current smoke ventilation methods used during electrocautery surgery. Review the optimum ventilation methods with the institutional mentor, health & safety officer, and engineering to compare performance and limitations.

During week three, evaluate surgical devices used for cauterization, identity, and document smoke levels produced by each method. The team will create a document establishing a baseline comparing new smoke ventilation methods. Reviewed with the institutional mentor, health & safety officer.

During week four consists of the evaluation of smoke ventilation systems in current ORs when using electrocautery surgery. The team will compare the current ventilation system against smoke evacuator systems to determine an optimum improvement in air quality. The institutional mentor, health & safety officer, engineering, will review the compared results.

During week five, evaluate smoke concentrations part per millions (ppm) to provide a baseline (ppm) levels of each device during electrocauterization procedures. Compare against OSHA and NIOSH specifications. The institutional mentor, health & safety officer, and engineering will review the performance results.

During week six, evaluate how the project site ORs currently measure air quality. Examine the effectiveness of air quality during electrocauterization surgery. The institutional mentor, health & safety officer, and engineering will measure results. During week seven evaluation, smoke evacuator candidates for a demonstration to consider for implementation into the OR project site. The institutional mentor, health & safety officer, and engineering, and Vendor, will measure the results.

PICOT

Within the operating room environment(P), how does the smoke evacuation system (I) compare to wall suction (C) affect the toxic smoke plume and air quality (O) within three months?

Congruence with Organizational Strategic Plan

The project mission statement aligns with the organization's strategic plans for the project site. The project mission is to improve the health status of people served by providing a full range of health-related services, including prevention, wellness, and education. The strategy is to be a leader in quality, service excellence, and patient safety, which is in congruence with this project. An efficient smoke evacuation system will improve air quality and reduce health risks for operating room personnel, surgeons, and patients. Not only will a safer environment exist, but this environment will attract more surgeons to perform more procedures with improved air quality when performing electrocauterization procedures. Creating a safer environment will be noteworthy because patients, surgeons, and newly qualified prospective operating room personnel will want to work with a facility that believes in excellence and creating a safe workplace environment.

Synthesis of Evidence

Several databases used to conduct the literature review. Databases searched included: EBSCO CINAHL, Cochrane Library, PubMed, Association of Perioperative Registered Nurses (AORN). Keywords used in the search were *surgery smoke plume,* Boolean operators "and" or "or" were used with the keywords to search for literature review articles (CINAHL, Cochrane Library, 2015). AORN Journal narrows the literature review search, for example, "and" retrieves articles containing every word in the search box, and "or" retrieves articles containing any of the word or phrases in the search box (EBSCO CINAHL, 2015). (Appendix H)

The summary of the literature search included several databases. Databases searched resulted in a few hundred to a couple of thousand matches. The date range searched then set 2009 to current, except the AORN journal, which was set from 2017 to current. Articles that were chosen were not limited to surgical smoke plume. The articles included a smoke evacuation system, ventilator system. A variety of articles that related operating room personnel overall experience included, but not limited to, the effects of the smoke plume, perception of OR experience, and education level of understanding the hazard of smoke. Due to the high volume of search results, even with the use of the Boolean operators, inclusion criteria included searching articles with the following: full-text articles, peer-reviewed articles, English language, and patients 18 years of age and older. The articles that met exclusion criteria included: pediatric patients, non-English language, were not full-text peer-reviewed, and the articles about information for other reasons that did not include improving air quality or smoke-free environment.

Evidence Review

Initially, the search produced well over 5,000+ results that included searching Google Scholar; therefore, databases searched were limited to Cochrane Library, AORN, in addition to CINAHL and PubMed within the EBSCO database. The total number of results was 1,253. After the review of abstracts, 1,203 articles were determined not to be related to the DNP project resulting in exclusion. The 1,203 articles excluded because they provided air condition (A/C) system information that did not include controlling smoke in OR; besides, the articles were on pediatric patients, non-English language, or not full-text peer-reviewed articles.

Out of the 50 relevant articles, an additional 30 articles excluded for the following reasons: 6 articles were specific to pediatric patients, and 26 articles were related to a variety of topics that were not relevant to controlling the smoke with smoke evacuation system, and health risk OR personnel. For this DNP project, a total of 20 articles were used that related to smoke

control, air quality management, and implementation smoke evacuator system, reducing the health risk the smoke impose on the OR personnel. When considering these 20 articles, there were several themes discussed in separate sections below.

The level of evidence has five levels that provide guidance when searching for answers to clinical questions. The five levels of evidence (LOE) (Appendix H)

Evacuator Resistance

Evidence has shown that surgeons have resisted the use of LEV and smoke evacuators in the ORs due to increased noise levels associated with the LEV. The noise level creates a challenge to communicate among the OR staff. However, the lack of LEV or a smoke evacuator uses compromise air quality in the OR (Romano, Gustén, De Antonellis, Joppolo, 2017; Okoshi et al., 2014; Shultz et al., 2017; Tan & Russell, 2017). Surgical smoke, which produced by using electrocautery devices during a surgical procedure, is the primary source of health risks exposure to OR personnel (Bree et al., 2017; Choi et al., 2014; Choi, Kwon, Chung, Kim, 2014; Fencil, 2017; Harvay and Novak, 2014; Steege, Boiano, & Sweeney, 2016; Watson, 2015; Wang et al., 2017; LOE V).

Smoke Evacuator

The project site falls in line with most operating rooms using wall suction as a method to control smoke. Air conditioning systems were put into place to address humidity and high particulate matter (HPM), the system did not achieve optimum performance. The wall suction does not meet the air quality level for a safe working environment as required, so an improved way for smoke control is a smoke evacuator, which is considered the optimum method for controlling smoke meeting required levels (Alsved et al., 2017; Bischoff, Kubilay, Allegranzi, Egger, Gastmeier, 2017; Barrick, and Holdaway, 2014 Memarzadeh, and Manning, 2004; LOE V)

Ventilation System

The ventilation systems, such as the LEV or the smoke evacuator, must be installed correctly to maintain a high confidence level and according to industry standards. Improving air quality in the OR during a surgical procedure is the primary objective to make operating rooms smoke-free environments (Okoshi et al., 2015; Bree et al., 2017; Dalal and McLennan, 2017; Harkavy & Novak, 2014; Shultz et al., 2014; Wang et al., 2017;). Ventilation systems must work to their maximum efficiency to keep contaminants from leaking in the air-breathing zones (Alsved et al., 2017; Harkavy &Novak, 2014; Lee et al., 2018; Okoshi et al., 2015; Shultz et al., 2014; LOE III). Therefore, smoke evacuation is essential, mainly when there is exposure to high particulate matter (HPM) and -medium particulate matter (MPM) tissue during surgery (Karjalainen et al., 2018).

Health Risk

The use of a smoke evacuation system is essential to OR personnel health and well-being. Doctors are exposed to smoke during their surgical time only, whereas the OR personnel are exposed to smoke for the length of the shift they work. Verbal and written complaints, concerning nausea and burning sensations, are the results of smoke contaminants being inhaled by OR personnel for a continuous length of time (Fencil, 2017; Harvey & Novak, 2014; Okoshi et al., 2015; Watson, 2015; York and Autry, 2018; LOE 1).

Ideal Smoke Evacuator

Systems supporting OR surgeries during cauterization procedures include the Neptune and Megadyne smoke evacuators. That is both excellent in removing the smoke plume. These two SES are remarkably similar in size, weight, and operation features. These two SES comes in a wall-size, cart size, and table size to accommodate all sizes of ORs. They are the most efficient smoke evacuator system to eliminate smoke in the ORs. (Megadyne ™, 2017; Neptune ™, 2015)

The smoke evacuator is a vacuum pump; it draws, extracts air smoke into the tubing that passes it through several inline filters, catching smoke contaminates, and returning the filtered air

to the OR. The handpiece of the smoke evacuator is positioned 1-2 inches from the smoke source in the operating room. The SES has a boom and arm that can be managed by surgeons when staff tasked with other efforts. (Megadyne ™, 2017; Neptune ™, 2015; LOE V).

Surgical smoke in the OR is the primary source for problems OR personnel, some of which may lead to more severe health risks if not addressed soon. The smoke-contaminated environment requires new technology to reduce or eliminate the smoke to improve the quality of air in the OR. A smoke evacuator system that can capture the smoke plume effectively, enhance the quality of air, and will allow the OR personnel to work in a smoke-free environment.

Theoretical Framework

The Kolb theory will guide the learning experience of the project. According to Kolb's Theory, active learning takes place when a learner cycle through four stages: 1) concrete learning -having experience, the opportunity to reflect on that experience 2) reflective observation -either through self-reflection or based on feedback from external sources developing new ideas 3) abstract conceptualization-relating theory/concepts to the lived experience 4) active experimentation-planning and trying out new ideas for future learning experiences (Kolb, 1984). Guiding learning experiences to allow the learner to cycle through all of these stages allows for more effective learning and to enhance skills. This project applied Kolb's Theory to ensure learners pass through each step of the process (Kolb, 1984). The learning experience - participating in this project provided the personnel and project team the opportunity to compare the current ventilation system against the smoke evacuator system.

Chapter II: Methodology

Project Design

A quality improvement project design, a systematic and continuance process that leads to measurable improvement in healthcare service, and the health status of the targeted group (Maran, Burson, Conard, 2017). The data was collected based on the evidence found in literature and

acquiring knowledge pertinent to hospital air quality, and the engineering process that control the ventilator system at the project site.

Setting

The setting was a five-unit observation bed facility that performed only orthopedic surgery. There were six ORs suites identified as medium and large operating rooms located in the greater Cincinnati area. The facility borders two states, Indiana, and Kentucky, and is an integrated system spanning across the Tristate region. The surgery center is committed to research and quality improvement by working with physicians across the region to ensure optimal care for patients who need specialized health services.

Population

The population includes Doctors (Surgeons), Registered Nurses (RN), Certified Physician Assistant (PA), Anesthesiologists, Certified Registered Nurse Anesthetist (CNRA), and Certified Scrub Technicians (CST). The goal of the project is to improve air quality and minimize health risks to all OR staff personnel.

Data Tool or Collection Instruments

The smoke evacuator system (SES) used to controls the smoke created by electrocautery devices. The smoke evacuator provides environment measurements while reducing and eliminating the smoke from the smoke source.

The OR questionnaire health card will document actual results measured in real-time after every electrocauterization procedure. Health cards will be collected and reviewed weekly. The purpose of the health card is for OR personnel to record their current conditions they are experiencing during each surgical procedure. The health card is an excel spreadsheet, Microsoft Office 365, excel version 2020, requesting answers such as length of surgery time, and effects of smoke on personnel wellbeing (See Appendix E). If the data does not show improvement for OR personnel, members of the interprofessional collaborative team, (environmental & safety officers,

OR manager, statistician) will review further research options to make improvements in the OR team data results.

The recording quality of air levels will occur daily: prior, during, and after any type of electrocauterization surgery. An air quality index (AQI) monitor will be incorporated into the OR to take air quality sample measurements on a continuous daily basis. The samples will show if the smoke evacuator is performing as desired.

Smoke analysis of smoke concentration levels parts per million (ppm) were recorded during the electrocauterization surgery procedures. The smoke data collected will be compared against OSHA and NIOSH permissible exposure limit. The OR personnel wear badges measuring smoke concentration levels in the OR. Measurement is recorded in parts per million (ppm), to ensure smoke concentration levels are in line with OSHA permissible level 0.1 ppm based on personal exposure for 8 hours and include the NIOSH short-term limit of 0.3 ppm base on 15-minute period. A Microsoft Office 365, excel version 2020, will be used to focus on the critical elements of the report that focused on exposure time and concentration (ppm) levels.

Vendor, Engineering, and OR personnel will evaluate the smoke evaluator system against its calibration specifications and determine if the project site moves forward with implementing the SES. The vendor will supply calibration data to be used to formulate a baseline for the SES performance. Engineering will assist in interpreting the data obtained from the vendor to assist in correlations between the design operating conditions versus the actual operating conditions in the ORs. The OR personnel will be educated on how to interpret the operating output to assist in establishing performance correlations. This effort performed daily to ensure the SES is operating within its designed calibration specifications.

Project Plan

First step: The project site leadership will send out a formal call for project implementation of the SES into specific ORs. The site leadership will disseminate the project purpose, objectives, and predicted outcomes to the Director of Surgery. The projects' purpose, objectives, and the anticipated outcome reviewed with the Director of Nursing and the Environmental Health and Safety Officer. These three persons identified as the senior leadership team, and they will appoint personnel to support all aspects of the project once the leadership team has reviewed and determined OR personnel to support the project. Staff who will support the project are as follows: OR Manager, Engineer, Chief Nursing Officer, Unit Base Educator, Director of Surgery, Director of Nursing, Surgeons, CRNAs, Nurses, Paper Author, Anesthesiologist, Staff – Nurses, and the Vendor representatives. Meeting rhythms will be created for timely discussions; these meeting rhythms will begin in August 2019 and continue until the project is ready to implement. The team will regularly convene in the surgery center huddle room to share information (Appendix G) and to discuss action items. The communication methods identified will be implemented; emails will be the formal communication median distributed to every team member and documented in a surgery center official electronic project folder. The surgery center educator will be accountable for providing education and training to OR personnel before implementation.

Second Step: Analyze Data from SES reference literature, the collected data will be analyzed by the project site team, who will then identify any shortfalls of the SES used in the OR and determine an action plan to address any shortcomings. Data results will support the education process for all educational sessions. Educational sessions will consist of PowerPoint presentations, pretest, and posttest. Documentation submitted to the surgery center folder labeled measurable and achievable data based on the time

frame and, with appropriate project site resources identified by the eighth week of the project.

Third Step: Research and collect LEV system data. The project team will research, collect LEV system data, and compare it to the SES, with a concentration on performance features to identify optimum system quality. Measurable and achievable outcomes based on the time frame and appropriate project site resources will occur by the seventh week of the project.

Fourth Step: Fourth Step: Evaluate Air Quality in the OR daily. The project site team will introduce an AQI monitor to record and document air quality readings during all surgical procedures using the SES. The Air Quality Index (AQI) instrument will monitor the air quality. The AQI instrument scale will classify the air quality level when the monitor scale reads between 0- 50 in the OR during electrocauterization surgery. When air quality is considered good, air pollution poses little or no risk to OR personnel. This data documented and reviewed regularly compared to previous air quality reading will suggest any improvements in air quality. All documentation submitted to the labeled folder measurable and achievable based on the time frame and, with appropriate project site resources, will occur by the tenth week of the project. The action will be to procure an AQI instrument if one is not available.

Fifth Step: Evaluate surgical devices. The project team will analyze smoke plume concentration levels of each electrocauterization device. Comparison to OHSA concentration limits and exposure limit 0.1 ppm for personal exposure is 8 hrs. and NIOSH short term exposure is 0.3 ppm for 15 minutes for the SES. The regulation requires all documentation submitted to the folder labeled measurable and achievable outcomes based on the time frame and, with appropriate project site resources, will occur by the ninth week of the project.

Sixth Step: Analyze project Site Policy and Procedures. The project site team will ensure the SES can support all surgeries performed with electrocautery devices and compare to local exhaust ventilation (LEV) policy. Policy and procedure will not be generic and will provide clear instructions/guidelines. All documentation submitted to the surgery center folder labeled measurable and achievable outcomes, based on a time frame and, with appropriate project site resources, will occur by the sixth week of the project.

Seventh Step: SES Transition into the OR. The project site team will perform engineering and vendor reviews on the designed SES. Personnel training will be initiated to all personnel by the vendor. Alternatively, any modifications to accept SES, install SES, perform trial simulations, and transition into service will occur.

Evaluation and Sustainability Plan

This project will be sustained at the project site with the leadership team overseeing the continuation of the OR nurses using SES when electrocautery devices used during surgical procedures. The leadership team, consisting of the Director of Surgery, Director of Nursing, and the Environmental Health & Safety officer, will oversee the transition from implementation to the sustainability of the project. Also, the leadership team will meet regularly to evaluate the status and performance of the project.

With continuing this project at the project site, no additional resources are needed as they relate to personnel, physical, and financial needs. Once the OR nurses were comfortable with setting up the SES, it only added approximately 10 minutes to their time in getting ready for their cases/procedures. There was still plenty of time left for staff to reflect and review instructions material of set-up SES before the beginning of their surgery procedure. The staff will not need to come in earlier than the usual standard time of one hour before their procedure to get prepared. A recommendation is to conduct this project at another site similar to the project site with implementing the lessons learned, the need to use the SES system to control smoke and improve

air quality in the OR during electrocautery surgery. When not using the SES system, it comprised OR personnel, as well as patients' health. By doing another location with this recommendation of using SES when electrocautery devices used during any surgeries will convey the importance and diminish or lessen the negate indifference of using SES.

After the implementation, a six-month annual review of the project lead by the leadership team will be conducted. Input from the surgery center support team will gather to evaluate of the smoke evacuation system. This six-month annual review will continue for two years. After the two years, a decision made whether or not to keep with the change in practice using SES.

Data Analysis

The clinical engineer, OR personnel, and the vendor will evaluate the SES against its calibration specifications. A smoke analysis - the OR staff will wear badges measuring smoke concentration in parts per million (ppm). Smoke data collected will be evaluated by the environmental & health safety officer and OR personnel. The data compared against the OSHA permissible exposure limit, which is 0.1 ppm based on personal exposure for 8 hours and will include the NIOSH short-term limit of 0.3 ppm based on 15 minutes.

The design analysis is performed by most SES manufacturers during the design phase of the smoke evacuator system. The smoke evacuator takes environment measurements while reducing and eliminating smoke, using filters, from the smoke source. The smoke evacuator eliminates smoke contaminates due to reaction to certain sensor material in the evacuator system. The sensors possess an electrical charge with a resistance. Resistance changes when smoke contacts the sensor. This process happens during the suction of air into the suction tubing (Vendor, personal email communication, October 25, 2018; Neptune, 2015).

The OR personnel questionnaire health card will reflect results measured in real-time and track the OR health experience during the electrocauterization procedure. Operating Room

personnel instructed to fill out a health report. The health report will contain information that will have each OR staff check off their current condition (See Appendix E). If the data does not show improvement for OR staff environment, the Director of Environmental & Safety and statistician will review research options to obtain correct data.

The pretest and posttest education will evaluate the OR personnel knowledge of smoke plume and its health effects on OR personnel health. The sign-test method used for statistical data can determine if there is a considerable difference between the pretest and posttest test knowledge of OR personnel. A statistician will be utilized as a resource.

The Air Quality Index (AQI) measurement monitor will measure the air quality in the OR. Manufacturer representatives provided AQI instrument education. Education included actual operation of the instrument and review of the adjustment features that are required to check performance. If the results are out of range, OR managers will notify the maintenance manager of what is out of range. The OR manager and maintenance manager work together to determine if surgical cases will need to be delayed or canceled.

IRB Ethical Issues

In the nurse health card survey, nurses will write their health experience when during an electrocautery procedure. Nurses informed how to fill out a survey regarding their health when a smoke evacuator system used or not used. Nurses advised they had the right to refuse to participate or could decline to answer any question(s) once consenting to participate. Nurses informed that their identity would not be used or tied to their data. Results from all data were collected, summarized, and analyzed in aggregate. Individual survey answers were anonymous. The health card survey nurses were identified by a generic badge number to protect privacy regulations and concerns. Nurses filled out the card, providing the information requested. Time in and time out information reflects the length of surgery time. The nurses also had an option to identify what type of SES used

during the electrocautery surgery procedure and list the smoke effects experience such as headache, nausea, eye irritation when SES was used and not use. No altered in the daily surgery schedule routine.

This DNP project received Quality Improvement approval from the project sites Committee Review Board (CRB; Appendix S). Oversight by the Institutional Review Board (IRB) was not required because the project determined that improvement smoke control would protect the OR personnel from the smoke hazard exposure in OR at the project site. Approval received a letter from Bradley University Committee on the Use of Human Subjects in Research (Appendix T). The study is not human subject research pursuant to 45 CFR 46.102(if), not meeting the federal definition related to human subjects. This author obtained training from Collaborative Institutional Training (CITI Program) from Bradley online training courses.

Chapter III: Organizational Assessment and Cost-Effectiveness Analysis

Organizational Assessment

The project site OR personnel currently suffer health risk concerns from the smoke effects due to the use of electrocauterization during surgery. There have been many health-related complaints regularly, and concerns of lack of leadership support affecting OR staff. The source of these complaints is smoke produced using electrocauterization instruments over a continued length of time. The smoke source creates an odor that is a nuisance, and it is similar to smoking cigarettes continuously that leads to itching/burning eyes, running nose, sneezing, nausea, lingering colds, and irritability, all affecting the performance of OR staff. The OR staff works an entire shift, which could vary between 8 to 12 hours per day over five days.

Complaints have been addressed generically with the use of over the counter medications to treat symptoms, and application of a simple face mask to help protect from the direct smoke source. These actions are not enough to address the immediate cause of the smoke. Smoke is the direct source of the health complaints stated by OR personnel. Currently, ORs are using the wall

suction system that meant to collect liquid. A rooftop unit (RTU), which consists of an air conditioning (A/C) unit, has a high-efficiency particulate air (HEPA) filter that also controls the temperature and humidity in the operating room. This process is not enough to address the smoke environment during the use of electrocautery instruments. This system has proven not to be the most efficient system to reduce smoke plume during electrocauterization surgery. One barrier that may surface during project implementation is the action of surgeons refusing to use the smoke evacuator system. The reason for surgeons not using the SES may be due to several reasons; it could be an obstacle in the way, an increase in noise level hindering communications, and simply a desire not to use. These issues could prove to be a factor in not permitting this project to be successfully implemented. Therefore, education is essential.

Cost-Effectiveness

The DNP proposal project cost to purchase two SES units is $28,000.00 (Appendix B). There is a direct and indirect cost for the acquisition and sustainability of the SES. The indirect cost is associated with copying the pre and posttest questions survey and the nurses' Health Card real-time surveys totaling $10.00. The nurses' costs shown are for information purposes only due to the education session was conducted during a time that was already reserved for monthly in-services. The direct acquisition cost includes the SES smoke evac tubing, filters, and AQI monitor. Tubing and filters are used for every case and disposed of after each case. SES units are a one-time purchase having a line item for cost information. The AQI monitor is a one-time purchase. When comparing the cost of current accessories including regular tubing, bovie pencil, suction canister, a suction liner to the project cost of the Smoke Evac, bovie pencil, and filter, the project cost is higher. Preventative maintenance is a cost associated with two Smoke Evacuator systems at $1000 each annually. Preventative maintenance provides support and sustainability for the SES units. The total implementation cost will be $465,000.00. The yearly cost for the SES disposables is $435,000 compared to the current price of disposables at $28,013. The difference in cost between the SES

disposables and the current use of disposables is $406,987. Even though there is a significant difference in the cost of disposables for the SES compared to the present disposables, protecting employee health is priceless (See Appendix B).

Chapter IV Results

Timeline: Data implementation process (Gantt Chart Appendix H).

The intervention consisted of bringing awareness to the operating room (OR) nurses concerning health risks due to smoke created in the ORs when using an electrocautery device during surgery. This smoke environment called smoke plume is harmful to personal health. Research has shown smoke contaminants created during electrocautery surgery contain hazardous bacterial viruses. However, the implementation of safety surgical masks and ventilation systems currently being used have fallen short of adequately protecting OR personnel during electrocautery surgery. The ventilation systems used to remove smoke contaminants are less efficient than current Smoke Evacuator System (SES) technology. The purpose of this project was to introduce new existing technology SES into the ORs as standard protocol while protecting OR personnel from smoke contaminants that cause health risks.

In March 2020, a kick-off meeting introduced the timeline of start and end dates for the staff to work toward meeting the successful completion of the implementation process. The schedule assisted the staff in achieving targets of the project promptly and enabled the team to adjust as required. The staff reviewed the plan, and there were not any significant concerns; therefore, the team was interested in moving forward. An education session took place at the project site in the staff lounge for OR nurses to review the following project plan and objectives: review current practice, proposed changes, rationale, evidence, and expected outcomes. This author held an OR staff meeting presenting a PowerPoint presentation titled "Improving Smoke Control in Operating Rooms with Smoke Evacuators." The education session provided the hazard health effect from the smoke generated in the OR. A positive outcome from the staff

education session was the identification of the importance of using SES when electrocautery devices utilized.

This author held a health card introductory education session on how to fill out a survey card with the OR staff. The focus of the meeting was to identify health risks related to the smoke environment in the OR. After the education session, the nurses participated in a health card survey utilizing the nurses' health card design to capture real-time health effects from smoke that is produced by electrocautery devices during surgery. The health card will assist in the interpretation of the compared analysis between the SES and the LEV system. The comparison will be the magnitude of the health risk effects.

This author, alone with vendor representative, led an introductory learning session of the SES. The focus was on SES preparation, setup, and the responsibility of the nurses supporting the SES during and after surgery. The smoke analysis report (Appendix D) shows smoke exposure time (hrs.) and concentration (ppm). Unfortunately, this data not evaluated on the project site due to outsourcing, scheduling, and cost complexities. The implementation objective proposed a task of collecting smoke data during electrocautery surgery, such as the start and end times, exposure time, Bovie setting, and the smoke concentration levels. The smoke analysis survey (Appendix D) omitted from the project plan due to facility outsourcing associated costs and schedules.

The evaluation of surgical devices identifies surgical devices used for electrocauterization on a continuance length of time. Using electrocauterization instruments in the OR produces smoke that is the source of these health risks. Smoke generated from the electrocautery (for cutting tissue), lasers (for tissue ablation), and ultrasonic scalpel (for tissue dissection) to determine what surgical devices generate large, moderate, small amounts of the smoke plume. The smoke analysis that measures smoke concentration (ppm) needs to be in progress to evaluate

these devices—however, the smoke analysis survey test omitted due to outsourcing scheduling and cost complexities. Therefore, no electrocautery device evaluation not performed.

The team identified an Air Quality Index (AQI) measurement monitor (Appendix F) to introduce OR personnel that measured the quality of air in the operating room during electrocautery surgery. The instrument is also used by atmospheric analysts that perform research and monitor air conditions in a contaminant environment. The OR staff will monitor air quality regularly and record the AQI numbers to determine if there was an improvement in the OR environment. The manufacturer representatives provided AQI instrument education. Education included the actual operation of the instrument and review of the adjustment features that are required to check the performance of the tool.

This author created a proposed budget to identify cost factors affecting the total cost of the implementation process of the project. The proposed budget identifies the required funds from buckets of money used for a particular type of project line item. The proposed budget examines the cost history of the current ventilation system versus the proposed SES.

This author proposed policy and procedure enforcing guidelines for SES usage by the OR staff. A policy and procedure will also provide clear guidance to support the maintenance of the SES. This author will present the policy and procedure to the oversight committee for approval.

The actual plan followed the initial plan per line item very closely except for the smoke analysis intervention and the evaluation of surgical devices. Once the smoke analysis omitted, the assessment of the surgical devices could not evaluate because they are linked together. The lesson learned outsourcing means having to go through a financial assistance process, and that takes time to generate.

Analysis of project outcome data

Ten operating room nurses attended an educational session on "Improving Smoke Control in Operating Rooms with Smoke Evacuators." Data analyzed included ten nurses who

received education on improving smoke control in operating rooms, and all of them completed a knowledge test before and after the educational session.

The nurses completed fourteen questions pretest-posttest (Appendix I) before and after the education session to determine if the course was productive. A sign-test divided into running questions (Q), Q 4 through Q14 with True/False questions, Q A demographics years of experiences working in OR environment (Appendix J), Q B no or right or wrong answer whether ever fitted for the N-95 mask. All nurses (10/10, 100%) reported that they adjusted for an N95 respirator mask. Q 3 nurses could circle as many reasons from a list of 12 possible reasons for not always using LEV while exposed to surgical smoke (Appendix K). The pretest scores ranged from 8-14 questions correct out of 14, with a mean of 11.3 and a median of 11.5 (Appendix R).

The posttest scores ranged from 13-14 questions correct out of 14, with a mean value of 13.8 and a median of 14. The results do show a trend towards increased knowledge after the educational session, $z = 3$, $p = .0027$. The results are significant at $p < .05$.

Based on the sign-test, posttest knowledge scores were significantly higher than the pretest knowledge scores (Appendix R).

In conclusion, the results show a trend towards increased knowledge after the educational session; therefore, the data demonstrate a trend towards increased awareness after the education session**.**

Kolb Theory is well suited and appropriate for learning the setup of SES because it allows for learners' internal cognitive processes. Kolb states, "learning involves the acquisition of abstract concepts that can be applied flexibly in a range of situations." According to Kolb Theory, the guided learning experience will allow the learner to cycle through all of the four stages for more effective learning. The Kolb theory design ensures that each nurse passes through each process before advancing to the next (Appendix M). The nurses who participate in the setup of the SES reflective observation will be able to occur as the nurses receive feedback.

The initial setup will include training on when to change the filer, what the bovie settings should be, and obtaining feedback. The OR nurses will go through abstract conceptualization, during which the nurses can debrief and relate the theory (content) that learned. New ideas that surface during the debriefing could lead to active experimentation in planning what can be done differently the next time they participate in SES setup or other quality improvement implementations (Kolb, 1984).

A health card is a real-time tool used to track the effects of the smoke plume in the OR during an electrocautery procedure when SES is used and not used. The comparison model between the SES and the LEV system viewed in (Appendix L). There were a total of 20 surveys issued to the nurses with a 75% completion rate. Nurses were identified by a generic badge number to protect privacy regulations and concerns. Nurses filled out the card, providing the information requested. Time in and time out information reflects the length of surgery time. The nurses also had an option to identify what type of SES used during the electrocautery surgery procedure and list the smoke effects when SES was used and not used. The real-time data on the badges show the number of times the participants completed the survey **(**Appendix O**)**; the time gives an average surgical duration of 1:56 hours. The column marked as other located on the top right-hand side of the study is for write-in comments only. The numerical unit value of 0.01 assigned to zero health risk identifying the usage of the SES during electrocautery surgery. To convey a real sense of the importance of zero-unit value compared to the other ventilation systems with a unit value of 1.0 used in electrocautery surgery. Participants experienced no health effects when the SES used. When the SES not used, participants experienced significant health-related issues. The results identified in the following bar graphs (Appendix E). Most written comments were related to the smoke being a nuisance. The bar graph shows the comparison between the SES and the LEV system about health risks.

In conclusion, the nurses experienced a high incidence of smoke effects such as nausea, headache, and eye irritation when the SES not used. When the SES was in use, 100% of the nurses reported there were not any health effects.

The AQI monitor measures the air quality by identifying pollutants in the OR during electrocautery surgery (Appendix Q**).** AQI is mainly used by government agencies to communicate to the public regarding pollution in the air and how polluted it is forecasted to become along with the risk to the public health (Air Quality Index (n.d.) The AQI designed to measure pollutants contained in the OR air during electrocautery surgical procedures. Readings will be monitored regularly by the OR staff during surgery when electrocautery used. There are six pollutants monitored; carbon monoxide, lead, nitrogen oxide, and ground-level ozone, also called particle pollution. The particle pollution is also known as particulate matter and sulfuric oxides. The air quality monitor has advanced laser technology enabling the monitor to provide highly accurate readings of tiny fine particles (PM 2.5) down to 0.3 microns. The monitor can provide real-time, historic, and forecast air quality information. The monitor also offers smart alerts and updates to ensure the OR staff is always breathing the cleanest air possible (Air Quality Index (n.d.).

This author proposes having a policy and procedure with guidelines for the use of SES. The pretest and posttest Q 3 nurses could circle as many reasons from a list of 12 possible reasons for not always using LEV while exposed to surgical smoke (Appendix K). It indicated that there were no clear instructions and or guidelines. The policy will provide clear guidance to manage surgical smoke plume and maintenance of the SES. The policy plan will help to protect patients and healthcare providers from the hazard effects of the smoke plume generated during surgical procedures (Appendix L).

The smoke analysis report (Appendix D) shows smoke exposure time (hrs.) and concentration (ppm). This data not evaluated on the project site due to outsourcing, scheduling,

and cost complexities. The implementation objective proposed a task of collecting smoke data during electrocautery surgery, such as the start and end times, exposure time, Bovie setting, and the smoke concentration levels.

The smoke analysis survey (Appendix D) omitted from the project plan due to facility outsourcing associated costs and schedules. Therefore, no electrocautery device evaluation performed.

Chapter V: Discussion

Finding

All OR personnel believed that the smoke plume is toxic and is hazardous. The exposure to surgical smoke is a health hazard for operating room personnel and can be toxic to one's health. The primary reason for concern is the smoke plume will continue as long as electrocauterization devices used, continually exposing OR personnel (Watson, 2015). In the past, air conditioning systems and natural face masks believed to protect OR Staff from the dangerous smoke contaminates in the OR air. Currently, research has determined these items are not enough to shield and protect OR personnel (Bree et al., 2017; Fencil, 2017; Wang et al., 2015; Shultz, 2014). With the importance of OR personnel health, leadership at the project site is supportive of this project. It is essential to understand that more research is needed; it takes longer to prove health issues and make improvements than that of a safety issue. The science used to support the intervention trial, and data were collected utilizing a nurses' health card survey. The survey supported the science that an SES will control the smoke in the ORs created by the electrocautery devices. The intervention had a positive impact on nurses in terms of understanding the importance of using an SES when electrocautery devices use.

One finding is the project site did not measure air quality in the OR during any surgery. Project site engineering used the AC system to measure temperature and humidity to ensure proper airflow during operation. The smoke evacuator system design is to reduce smoke from the

OR during electrocautery surgery. The smoke evacuator can operate per design without the support of the AQI monitor. The AQI monitor is an instrument used to measure the air quality in the ORs. The AQI monitor introduced to protect the site as a means of measuring the air quality.

Limitation or Deviations from Project Plan.

As with any potential practice change, obstacles can arise. Possible impediments to this project could have involved a lack of buy-in from the nurses due to not understanding the project's importance, low team member participation, and time constraints. Proper planning, education, evidence sharing, and involvement of the OR nurses helped with understanding the value of the project and obtaining buy-in by the personnel. At first, there was one nurse reluctant to buy-in to the change in the practice of using SES. After a further explanation of the importance of using SES during an electrocautery procedure and realizing how supportive her co-workers were of this change in practice, she became supportive of the difference as well. The OR nurses gave instructions on how to change the filters, how to change bovie settings per the doctor's preference. After the instructions, it allowed the nurses time to reflect and debrief. The reflecting method is when nurses verbalize the understanding of what they learned. The reflection method will enable nurses to assess the knowledge of the information that learned and if any further information needs to be reviewed again for successful learning (Kolb, 1984). Time constraints could have made it difficult for nurses to participate.

The time constraints consisted of not having enough time to spend with SES due to a short timeline of the SES unit being at the site or encountering pressure from the surgeons or anesthesia to start the case quickly. Plans were in place for the nurse manager or nurse educator to provide the instructions if there were constraints that prevented the OR nurse from learning, reflect, and debrief. Before beginning the intervention, surgeons and anesthesia providers informed of the trial of the SES at the project site. The surgeons decided to do a pilot study of SES and their attachments (disposable; accessory; bovie) that was used in conjunction with the SES. From the

reviews of the pilot study, they were incredibly positive regarding SES. There was one surgeon that refused to use the SES, and the reason is unknown. This may have occurred during the implementation of this project. The reason for surgeons not using the SES may be due to several reasons; potentially an obstacle in the way, no individual desire to learn how to use attachments, and general indifference.

The nurses informed if, at any point in time, the surgeons or anesthesia provider rushed them, they were to immediately notify the nurse manager who would then re-explain the importance of trialing the SES. The real-time nurses' health card had a real, triumphant moment with the OR nurses. Even with the small sample size of nurses that participated in the survey, it was overall fitting for the surgery center. The nurses found that when the SES used, it only added approximately five minutes to their time of setting up for a case, and there was no smell of smoke plume; therefore, no health effect issues noted. Even the X-ray tech who is in the OR for all total joint procedures commented on how well the SES eliminated the smoke plume smell.

The virtual digital conferencing used for meeting met the new normal-as we go through the COVID 19 pandemic crisis—the digital programming hosted several options to enhance a conference meeting utilizing Information Technology (IT).

Limitations

One major shortcoming for the nursing staff to attend the virtual conferencing, as participants, is a conflict in the surgery schedule. A limitation and lesson learned a team that not trained in IT or virtual digital conferencing meetings spent valuable time searching for experienced people to conduct digital meetings. The total cost is high for the smoke evacuator system supporting electrocautery surgery. This total cost reflects an expensive project cost for implementing the project. The cost associated with the smoke evacuator system and preventative maintenance falls in line with current purchases throughout the industry, the accessory cost based

on the total number of surgeries performed at the project site. The number of operations drives the price for the SES accessory usage in electrocautery surgery compared to LEV cost.

Implication

Practice Change: Sustainability in practice change will be a learning curve of utilizing the SES for every cauterization case. Implementing any change to nursing practice must be supported by evidence-based incentives. Any practice change will also require staff education. In this project, education is related to teaching the negative health impact of surgery smoke exposure, and the importance of using SES at all time during electrocautery surgery. The statements conveyed the need to implement an SES system to control smoke and improve air quality in the OR during electrocautery surgery. The project team is currently determining a date for project dissemination to all stakeholders and throughout the organization. There are six additional sites in the system that is associated with the Orthopedic Surgery Center; therefore, coordination of dissemination between all impacted facilities is necessary to provide efficient dissemination of the SES project.

Future Research: This project is essential because it addresses the toxic effects of the smoke plume on all OR personnel in the surgical environment when using electrocautery devices. Continuing efforts to improve education models and support scientific research will translate into the empowerment of interdisciplinary collaboration while working together to facilitate progress. Surgical smoke is the primary source of health problems for OR personnel, which may lead to more severe health risks if not addressed. The smoke-contaminated environment requires new technology to reduce or eliminate the smoke levels to improve the quality of air in the ORs during electrocautery surgery.

Nursing: Additional education is needed for nursing to understand the impact of surgical smoke plume on personal health. This project involves practice change, and this change will impact the OR nursing environment and impact patient safety at the project site. Potentially, a

global impact of all facilities that perform surgeries can become smoke-free by using the SES. Nursing has a platform to advocate for change. The state of Rhode Island and Colorado legislation has mandated that hospitals organization equip ORs with the latest SES technology to control the smoke (AORN, 2019). Hopefully, the vision in other states will follow.

Health Policy: A policy helps re-enforce regulatory laws at the state and local levels. It also helps address the necessary change in practice. There is a significant need for governing regulatory bodies such as NIOSH, to implement specific standards that provide strong language and support the use of SES. This project addresses the health risk problem and improving the smoke control in the ORs during electrocautery surgery by the implementation of an SES. Health policy initiation can enforce and elevate the education and competency need, while also encouraging accountability for employers.

Chapter VI: Conclusion

Value of the Project.

Surgical smoke, which produced by using electrocautery devices during a surgical procedure, is the primary source of health risk exposure to OR personnel (Bree et al., 2017; Choi et al., 2014; Choi, Kwon, Chung, Kim, 2014; Fencil, 2017; Harvay and Novak, 2014; Steege, Boiano, & Sweeney, 2016; Watson, 2015; Wang et al., 2017). The use of a smoke evacuation system is essential to the health of OR personnel. Verbal and written complaints, concerning nausea and burning sensations, are the results of smoke contaminants being inhaled by OR personnel for a continuous length of time (Fencil, 2017; Harvey & Novak, 2014; Okoshi et al., 2015; Watson, 2015; York and Autry, 2018).

This DNP project consisted of improving smoke control in ORs with the newest SES at the project site. The primary data demonstrated that the use of an SES when an electrocautery device is utilized in the OR proved to be effective. Even though we could not use the new system initially desired due to cost effectivenesss, The QI project proved that supporting and

encouraging the use of current SES proved effective in mitigating immediate OR staff negative systems reported in the past.

The fourteen-questions survey that analyzed before the presentation and fourteen-questions utilized the posttest showed an increase in OR staff knowledge regarding smoke plume in the OR. The project applied the use of a real-time health card survey to determine the effects of smoke on OR staff. The real-time health card survey shows that when SES used, the participants did not experience health issues. With the real-time survey results, this helps solidify predictions when an SES is used to control smoke in the OR, and the OR staff does not experience health effects. Surgeons that used the SES gave positive reviews, which was a plus because many of the surgeons are stockholders in the OR.

DNP Essentials

Every essential has different meanings, and each was equally important in this QI project. *Essential I, the scientific underpinnings of practice relate to nursing practice*. Following the scientific research, the OR personnel elevated by integrating knowledge that the smoke produces in OR when using electrocautery devices is a hazard to ones' health. The evidence-based experience promoted and lifted using an SES to control the smoke when electrocautery devices use as best practices.

Essential II Organizational and systems leadership allowed systems thinking; it allowed me to look from a different lens organization and system leadership thinking. Interacting with the project site professionals brought awareness to the OR current practice elevated by scientific research findings and the project promotion as a quality improvement project for OR personnel and patients. System thinking raised insight budget planning (balance sheet, salary expense statement, and statement of cash flow). System thinking elevated DNP leadership skills to a higher level. It raised my confidence with the other interprofessional.

Essential III, clinical *scholarship, and an analytical method for evidence-based practice*; This essential was critical for my project to be successful. Substantiate data for early intervention and analyzing the data to meet the outcome as it relates to solving complex practice situations. Monitoring the evidence supported the facts regarding smoke contaminants in OR environment that generated during an electrocautery surgical procedure is a hazard to OR personnel health. A smoke evacuator system is required.

Essential V, health care policy for advocacy in health care; To advocate for change in practice. The needs of a new policy that supports using the smoke evacuator system.

Essential VI Interprofessional, *interprofessional collaboration for improving patient and population health outcomes;* Roles and responsibilities differ with each discipline. Elevated the needs to be a good listener to be able to communicate effectively. Working with different professionals respecting their contribution help with collaboration, and it helped raise awareness and support better patients and OR staff outcomes (Essential of Doctoral Education for Advanced Nursing Practice, 2006)

Plans of Dissemination

In August 2020, this project will be disseminated to the DNP faculty and cohort of Bradley University. Discussions have taken place among top leadership management to implement this change in practice using the smoke evacuator system throughout the organization by way of Virtual using WebEx, Zoom, or Skype, and Streaming depending on facility capability. There are six additional satellites center affiliated with the surgery center; therefore, this will potentially have a positive impact throughout the organization using a smoke evacuation system that will protect OR personnel and patients when electrocautery devices use during surgical procedures.

The DNP project paper will be submitted to the DNP Scholarly Project e - Repository for open access. Another way to disseminate the results is to complete an application to present a

poster at the Tri-State Nursing Excellence Symposium in the Spring of 2021. The final method for disseminating is to publication in the AORN journal.

Attainments of Personal and Professional Goals.

The DNP student accomplished all desired personal and professional goals. More specific education is needed in the area of smoke plume and will assist this author in becoming an expert on the topic. The DNP student has accomplished the confidence to be a role model supporting the next generation of DNPs to continue learning. The professional goal is to develop relationships with senior DNP that have successfully managed to build and accomplish respect in the health care organizations.

References

Air Quality (n.d.*). In Collins English Dictionary*. Retrieved from https://www.collinsdictionary.com/dictionary/english/air-quality

Air Quality Index (n.d.). *ASPE.* Retrieved from http://www.ashe.org/compliance /ec_02_05_01/01/specialdept_or.shtml

Alsved, M., Civilis, A., Ekolind P., Tammelin, A., Erichsen Anderson, A., Jakobson, J., Svenson, T., Ramstorp, M., Sadrizadeh, S., Larsson, P-A., Bohgard, M., Santl-Temkiv, T. & Lo¨ndahl, J. (2017). Temperature-controlled airflow ventilation in operating rooms compared with laminar airflow and turbulent mixed airflow. *Journal of Hospital Infection 98* (2), 181-190. doi:1016/jhin.2017.10.013

Barrick, R. J., & Holdaway, S. (2014). Special departmental HVAC issues: Operating rooms. *The American Society for Health Care Engineering of the American Hospital Association (ASHE).* Retrieved from http://www.ashe.org/compliance/ec_02_05_01/01/specialdept_or.shtml

Bischoff, P., Kubilay, N., Z., Allegranzi, B., Egger, M., & Gastmeier, P. (2017). Laminar airflow ventilation was compared with conventional ventilation to assess their effectiveness in reducing the risk of surgery site infections, a systematic review, and meta-analysis. *Lancet Infection Disease* 17 (5),553-561. doi:10.1016/S1473-3099(17)30059-2

Bree, K., Barnhill, S., & Rundell, W (2017). The dangers of electrosurgical smoke to operating room personnel: A review. *65*(11), 517-526. *AORN Journal.* doi:10.1177/2165079917691063

Carbin, J. (2001). A primer on smoke evacuation: Expert advice to help you clear the air in your OR. *Outpatient Surgery.* Retrieved from https://www.outpatientsurgery.net/issues/2001/06/a-primer-on-smoke-evacuation

Caywood, K. (n. d.). Ensuring patient safety and compliance with CMS and joint commission Requirements. *Joint Commission Resource* Retrieved from https://www.scha.org/files/caywood.jointcommissionrequirements.pdf

Choi, S., H. Kwon, T., G. Chung, S., & K. Kim, T-H. (2014). Surgical smoke may be a biohazard to surgeons performing laparoscopic surgery. *Surgical Endoscopy*, *28*(8), 2374-2380, doi:10.1007/s00464-014-3472-3

Dalal, A.J., & McLennan, A. S. (2017). Surgical smoke evacuation: A modification to improve efficiency and minimize potential health risk. *British Journal of Oral and Maxillofacial Surgery* 55(1) 90–91. doi.org/10.1016/j.bjoms.2016.03.029

Eggers, P., E., & Thapllyal, H., V. (1998). United States patent. Patent number 5,843,019. Retrieved from: https://patentimages.storage.googleapis.com/bd/e7/32/9788477c83c867/US5843019.pdf

Essentials of Doctoral Education for Advanced Nursing Practice. (2006). American Association of Colleges of Nursing. Retrieved from www.aacn.nche.edu.

Fencil, JL (2017). Guideline implementation: Surgical smoke safely. *AORN Journal.* 106 (5) 488-497 doi.org/10.1016/j.aorn.2017.03.00

Harkavy, L.M., & Novak, D.A. (2014). Clearing the air: surgical smoke and workplace safety practices. *AORN Journal* 8 (6) 1-7 doi: 10.1097/01.ORN.0000453446.85448.2f

How is air quality measured? (n.d.). *In Sci Junks.* Retrieved from https://scijinks.gov/air-quality

Karjalainen, M., Kontunen, A., Saari, S., Ro¨nkko, ¨ T., Lekkala, J., Roine, A., & Osksala, N. (2018). The characterization of surgical smoke from various tissues and its implications for occupational safety. *PLoS ONE, 13*(4). doi.org/ 10.1371/journal.pone.0195274

Kolb, D.A. (1984). Experiential learning: Experience as the source of learning and

development. (What is the textbook name? The textbook name goes here in *Italics.* Englewood Cliffs, NJ: Prentice-Hall.

Lee, T., Jhy-Charm, S., LeBouf, R.F., Burns, D., Schwegler-Berry, D., Kashon, M., Bowers, J., & Harper, M. (2018). Surgical smoke control with local exhaust ventilation: Experimental study. *Journal of Occupational and Environmental Hygiene, 15(*4), 341-350. doi: 10.1080/15459624.2017.1422052

Megadyne ™ Mega VA (2017). Ethicon represents the products and services of Ethicon, Inc., *Johnson &Johnson.* Retrieved from https://www.ethicon.com/na/

Memarzadeh, F. & Manning, A.P. (2004). Comparison of operating room ventilation systems in the protection of the surgical site. *ASHRAE.* Retrieved from https://www.researchgate.net/publication/234094747_Comparison_of_Operating_Room_VentilationSystems_in

Moran, K., Burson, R., & Conrad, D. (2017). *The Doctor of Nursing practice scholarly project.* Burlington, MA: Jones and Bartlett.

National Institute for Occupational Safety and Health (NIOSH; 2005). Exposure Limits for Air Contaminants. Retrieved from https://www.grainger.com/content/qt-exposure-limits-air-contam-232

Neptune E---Sep Surgical Smoke Hazards Brochure (2015). Uniting against the hazards of surgical smoke. *Stryker.* Retrieved from https://www.neptunewastemanagement.com/ESEP

Occupational Safety & Health Administration, US Department of Labor (OSHA; n.d.). Surgical suite, 447-452. Retrieved from https://www.osha.gov/SLTC/etools/hospital/surgical/surgical.html#content

Occupation Safety and Health Administration (OSHA; 1993). Air contaminants, (29 CFR, 1910.1000). Retrieved from https://www.ohsa.gov/

Okoshi, K., Kobayashi, K., Kinoshita, K., Tomizawa, Y., Hasegawa, S., & Sakai, Y. (2015). Health risks associated with exposure to surgical smoke for surgeons and operation room personnel. *Surgery Today*, *45*(8), 957-965. doi:10.1007/s00595-014-1085-z

Romano, F., Gustén, J., De Antonellis, J., Joppolo, C.M. (2017). Electrosurgical smoke: Ultrafine particle measurements and work environment quality in different operating theatres. *International Journal of Environmental Research and Public Health*. doi:10.3390/: jerph14020137

Schultz, L. (2014). An analysis of surgical smoke plume component, capture, and evacuation. *AORN Journal.* doi.org/10.1016/j.aron.2013.07.020

Tan, E., & Russell, K. (2017). Surgical plume and its implications: A review of the risk and barriers to a safe workplace. *ACORN: The Journal of Perioperative Nursing in Australia. 30*(4), 33-39. Retrieved from https://search.informit.com.au/documentSummary;dn=317498588275190;res=IELHEA

Steege, L.A., Boiano, J.M., Sweeney, M.H (2016). Secondhand smoke in the operating room? Precautionary practices lacking for surgical smoke. *American Journal of Industrial Medicine*, 59 (11) 1020–1031. doi: 10.1002/ajim.22614.

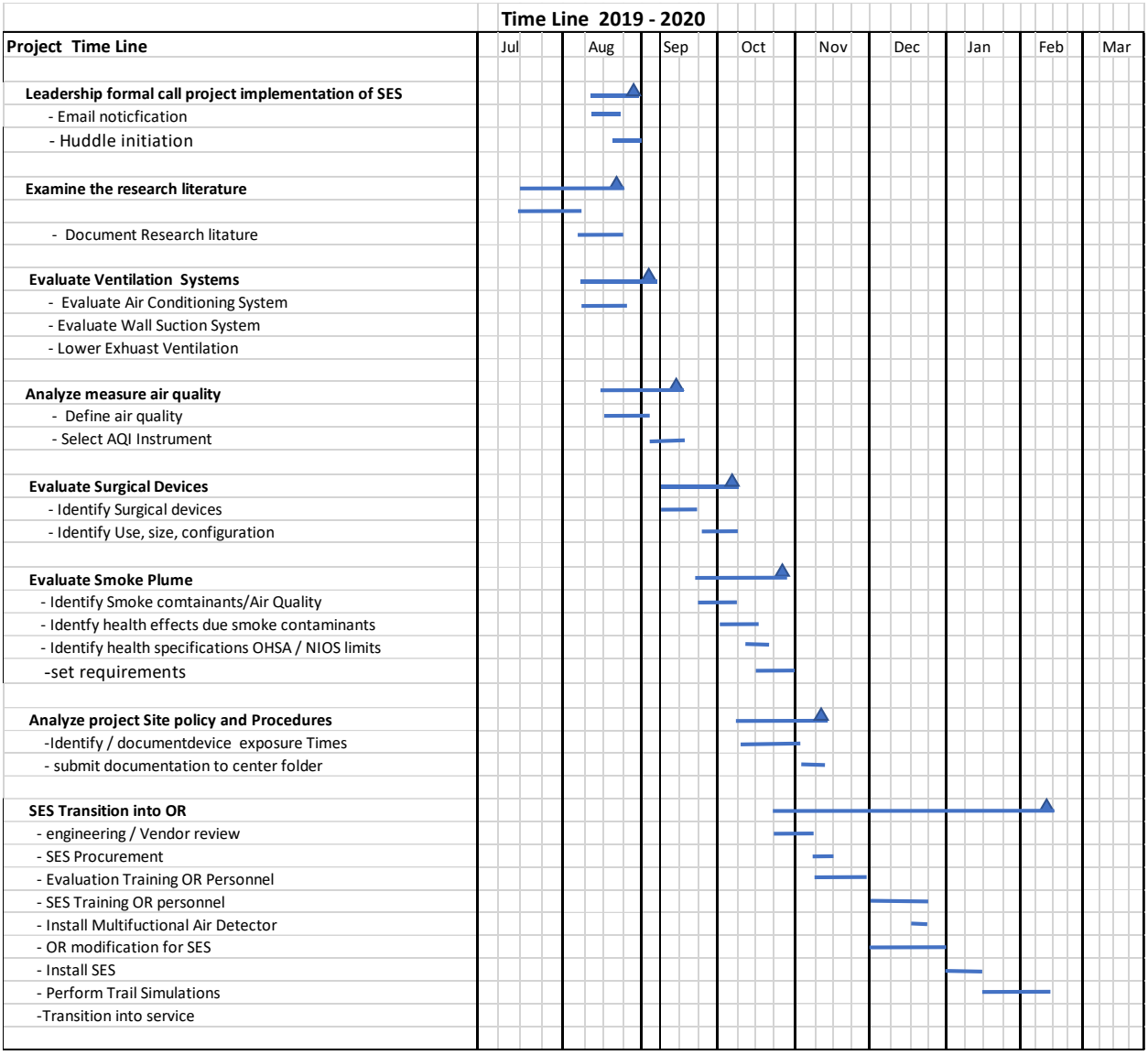
Wang, F., Hong, K., Mo, F., Chun, G., Ma, B., Dai, G.H., Shi, Y., Zhu, H., Liang, Z., Ding, W.Y. (2015). Evaluation of fine particles in surgical smoke from a urologist's operating room by time and by distance. *Int Urology and Nephrology* 47 (10) 1671-8 doi.org/10.1007/s11255-015-1080-3

Watson, D. S. (2015). Surgical smoke: What do we know? Retrieved from https://www.researchgate.net/publication/265081394

York, K., & Autry, M. (2018). Surgical smoke: Putting the pieces together to become smoke-free. *AORN Journal*, *107*(6), 692-703. doi.org/10.1002/aorn.12149

Appendix A

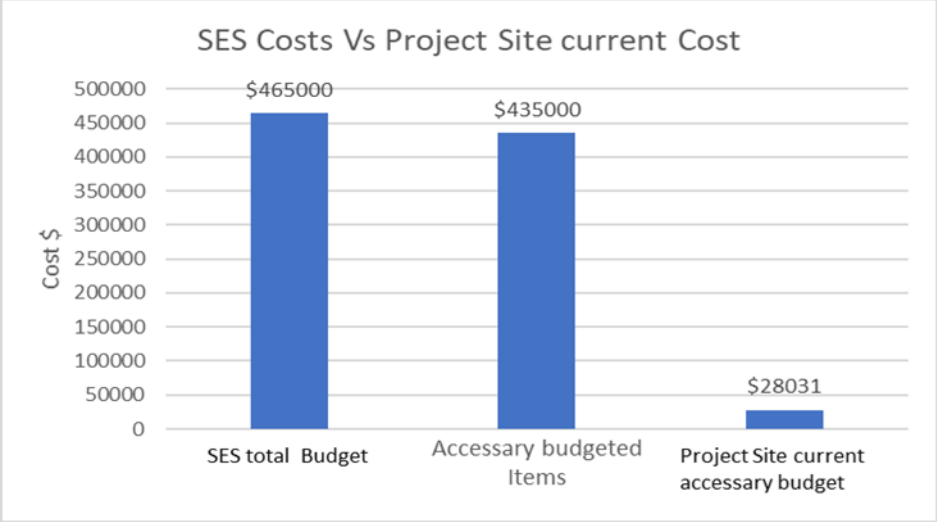
Project Timeline



Appendix B

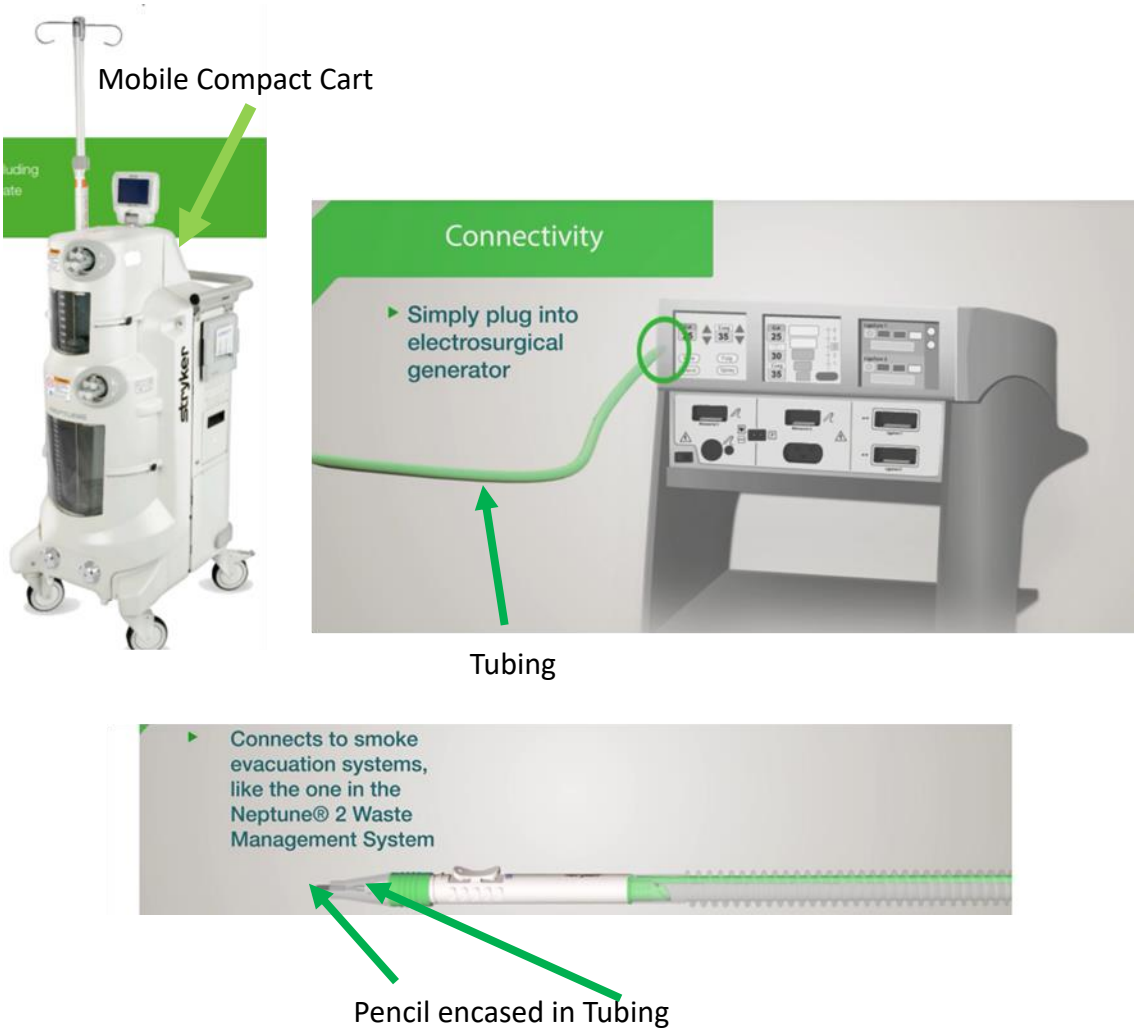
DNP Smoke Evacuator Project Budget

Budget Item	In-kind cost/Hosptal	Average Calculation	SES Project Accessary Costs $	Project Site Current Accessary Costs $
Project Indirect Cost $				
Paper Survey	$0.02 per paper x 500 sheets per pack = $10.00	NA		
Nurses Education Survey Pre & Post Test Project education	$35.00 x 10= $350.00	Average RN hourly rate = $35.00 per hour Approximately 10 Nurses		
Nurses Health Card document health risks Real time survey monitoring	$35.00 x 10= $350.00	Average RN hourly rate = $35.00 per hour Approximately 10 Nurses		
Project Direct cost		NA		
Smoke Evacuators	$14,000.00 x 2 = $28,000.00	NA		
Preventative maintence	$1,000.00 x 2 = $2000.00	NA		
Smoke Evac Tubing	$39.00 x 3750 x 2 = $292,500.00	NA	$39 x 3750 = $292, 500.00	
Filter	$19.00 x 3750 x 2 = $142,000.00	NA	$19 x 3750 = $142,000.00	
Air Quality Instrument AQI	$15.00 x 2 = $30.00			
Total DNP Project Cost	**$465,030.00**		**$435,000.00**	
Project site current cost				
Bovie Pencil	$4.00 x 3750 = $15,450.00	NA		$4.00 x 3750 = 15450
Suction Canister	$1.10 x 3750 = $4,163.00	NA		$1.10 x 3750 = $4,163
Suction Liner	$1.60 x 3750 = $5850.00	NA		$1.60 x 3750 = $5850
Suction Tubing	$0.68 x 3750 = $2550.00	NA		$0.68 x 3750 = $2550
Total Cost	**$28,031.00**			**$28,031.00**
Project Variance	**DNP project Cost - Project site current cost = $435,000.00 -$28,031.00 = $406,969.00**			



Appendix C

Cart smoke Evacuator



Neptune E---Sep Surgical Smoke Hazards Brochure 2015. Uniting against the hazards of surgical smoke. *Stryker* https: www.neptunewastemanagement.com/ ESEP

Appendix D

Smoke Analysis

		SMOKE ANALYSIS REPORT					
SAMPLE No.	DATE	PROCEDURE / PROTECTIVE EQUIPMENT	START TIME (hrs)	END Time (hrs)	EXPOSURAL TIME (hr)	BOVIE SETTING	CONCENTRATION (ppm)
The OSHA permissible exposure limit is 0.1 ppm based on personal exposure for an 8 hour period.							
There is no short-term limit. The NIOSH short-term limit is 0.3 ppm, based on 15 minute period.							
The level measured is below the short-term exposure limit							
Note: " Less than" value is the minimum quantitation level for the exposure time used.							

Smoke analysis Report

Exposure time (hrs.) and concentration (ppm) are critical elements of this data analysis report. The output data will be retrieved and evaluated daily.

Appendix E

Health Card

				Health Card					
	Time		SES Y/N	Type	Nausea	headache	Run Nose	burn eyes	other
BADGE #	in	out		C/T/W					
Type = C=Cart									
T=Table									
W=Wall									

Appendix F

AQI Measuring Instrument

Appendix G

Communication Tools

Dear Staff,

You will soon receive an invitation to participate in a Quality Improvement project, "Improving Smoke Control in Operating Rooms with Smoke Evacuator System." This is an opportunity for you to provide honest and open feedback concerns your working environment.

Your feedback is valuable. Your responses will help shape critical decisions making improvements within our organization to support this Quality Improvement project. The project will take approximately nine months to complete. The scope of this project will not interfere with your regular operating responsibility. There will be simple short answer surveys, and at some point, you will be asked to wear a badge to evaluate the level of smoke during procedures when electrocauterization devices in use.

We will not use the results to identify the views of individuals, and strict rules are in place to safeguard your anonymity at every stage of the process. The response from you will be taken seriously by our senior management team and will assist us in continuously improving our workplace environment.

Regards,

Morning Huddles Communication Template

Morning huddles consist of verbal communication with team members in a brief, clear, and timely format. The huddle will provide OR staff surgery assignments and any special instruction required for a particular surgery. A huddle is a place where all members of the operating team can exchange all information concerning schedule surgeries. Managers will lead the huddle discussions while disseminating information. It will be the OR manager's responsibility to ensure all information is correct, current, and understood by the entire OR Staff. Daily huddles convey the following structure: Share/Acknowledge/ Verify/ validate/ the information

Appendix H

Summary of Literature Review

Search Terms	CINAHL	PubMed	Google Scholar	Cochrane Library	AORN
Smoke Plum Operating Room	3/18	2/12	4/89	0/26	1/36
Airflow Ventilation	0/2	2/36	0/166	1/4	1/54
Implementing Smoke Evacuation	2/67	0/1	2/50	1/7	10/65
Potential hazard of surgical smoke plume	2/41	1/3	2/36	0/61	12/34
Staff Education	3/7	1/6	4/26	1/15	2/24

Totals for all Databases and Search Terms	Total number of hits = 1,253	Total number of Relevant hits = 50

Summary of Level of Evidence

Type of Evidence	Level of Evidence	Number of Articles per Level (N=20)	Percentage Articles per Level (N=20)
a. Systematic reviews	I	3	15%
b. Analyzing Smoke	II	2	10%
c. Controlled Studies	III	1	5%
d. EBP Implementation and QI Project	IV	7	35%
e. Expert Opinion	V	7	35%

Appendix I

Gantt Chart Interventions/Outcomes

Task	Start January 2020	End August 2020	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	June 2020	July 2020	Aug 2020
Proposal Presentation										
Meet with OR staff										
Develop Education session: PowerPoint presentation pre/post-test										
Vendor/Rep Education session SES										
Completed internal surveys pre-intervention										
Start invention										
Completed internal survey post-intervention										
Start processing internal data										
Analysis of internal surveys										
Proposal Budget										
Disseminate										

Appendix J

Pre/Posttest

"Improving Smoke Control in Operating Rooms with Smoke Evacuators"

A. The number of years (in career) working in areas where surgical smoke was generated:
   a. < 4 years
   b. 5 years – 10 years
   c. 11 years – 20 years
   d. > 21 years

B. Were you fit tested for the N95 respirator mask? Circle **Yes** or **No**

Pre and Post RN Education Test

1. Type of Local exhaust ventilation (LEV) used (Please circle one):
   a. Smoke evacuation system
   b. Room (wall) suction

2. Personal protective equipment used (Please circle one):
   a. Regular face mask
   b. Respirator N-95

3. Reasons for not always using LEV while exposed to Surgical Smoke (Please may circle than one)
   a. General room ventilation was sufficient to dissipate smoke
   b. Used a different system to remove smoke
   c. An engineering control was used
   d. Not part of our protocol
   e. Exposure was minimal
   f. Not provided by the employer
   g. Not readily available in the work area
   h. No one else who does this work uses LEV
   i. Not permitted by the surgeon
   j. Too uncomfortable or difficult to use
   k. Too bulky or noisy
   l. Concerned about raising the patient's anxiety

Circle true (T) or false (F):

4. **T** **F** Surgical smoke, also known as a surgical plume, is generated when procedures or treatments require the use of electrosurgical devices.

5. **T** **F** Surgical smoke is toxic and hazardous to health and is similar to cigarette smoking.

6. **T** **F** NIOSH recommends the use of local exhaust ventilation (LEV) smoke evacuators.

7. **T** **F** Best practice to consistently reduce smoke plume exposures minimizing the hazard and potential health effects.

8. **T** **F** Surgical smoke exposures have been linked to acute adverse health effects in exposed healthcare employees, including eye, nose, and throat irritation headache; cough; nasal congestion; and asthma and asthma-like symptoms.

9. **T** **F** Governing bodies that oversee medical organizations use passive language in the regulations with words like recommended, encouraged, and suggested.

10. **T** **F** The electrosurgical device and method allow the surgical team to perform electrosurgical procedures, such as ablation and cutting of body tissue while limiting the depth of necrosis and limiting damage to nearby sites.

11. **T** **F** There is a direct relationship during electrocauterization surgery between the carbon monoxide released in the air and OR personnel experiencing nausea, and headaches.

12. **T** **F** Currently, air conditioning systems and natural face masks are assumed to protect OR staff from the dangerous smoke contaminants in the OR air.

13. **T** **F** There are emerging technologies to improve the quality of air in the OR by eliminating the smoke plume. The smoke evacuator system (SES) technology is used to improve air quality by removing as much of the smoke plume as possible.

14. **T** **F** In the past, researchers suggested that only team members at the direct surgical site were exposed. However, research has proven that all members of the surgical team within the surgery area are exposed to a similar level of surgical smoke.

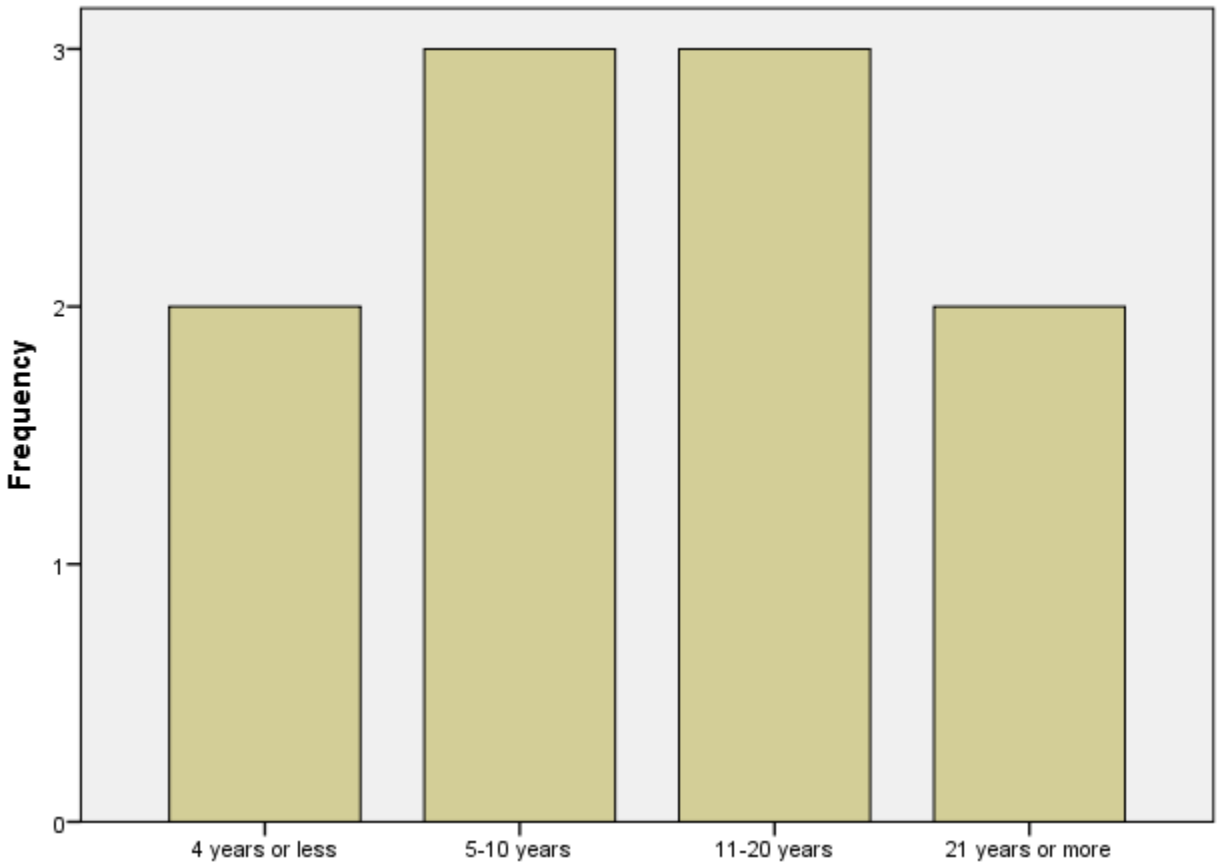
Appendix K

DATA ANALYSIS <u>Demographics of the Nurses:</u>

Data analyzed included ten nurses who received education on improving smoke control in operating rooms and completed a knowledge test before and after the educational session.

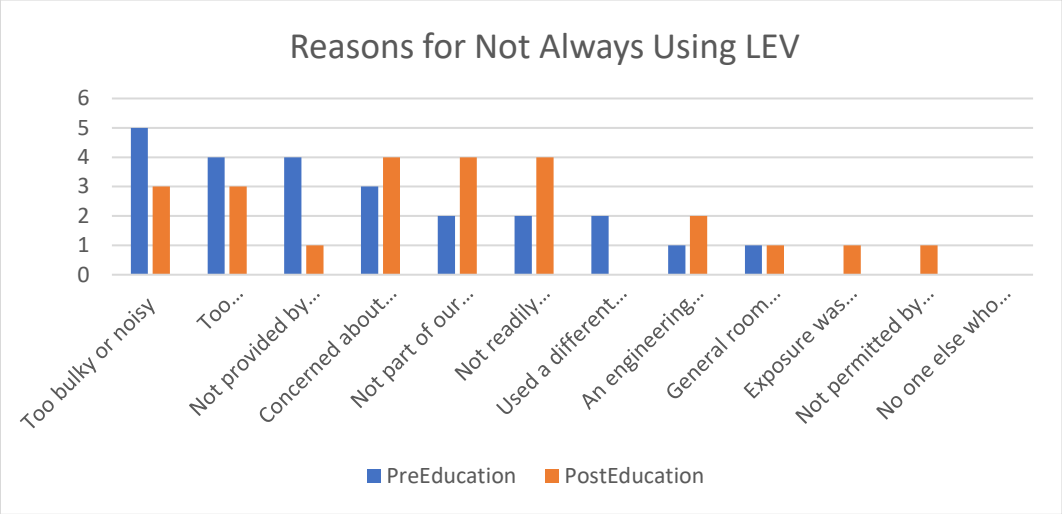
The nurses reported having a varying number of years that they had worked in areas where surgical smoke was generated:

- 2 (20%) had four years or less working in these areas
- 3 (30%) had 5-10 years working in these areas
- 3 (30%) had 11-20 years working in these areas
- 2 (20%) had 21 years or more working in these areas



Appendix L

- Five nurses circle too bulky or noisy.
- Four nurses circle not provided by the employer and too uncomfortable to use.
- Three nurses circle concerned about raising the patient's anxiety.
- Two nurses circle used a different system to remove smoke, not part of our protocol, and not readily available in the work area.
- One nurse circle exposure was minimal, and no one else who does this work uses them and not permitted by the surgeon.



After the education, the reasons listed from most to least frequently were:

- Four nurses circle not part of our protocol, not readily available in the work area, and concerned about raising the patient's anxiety.
- Three nurses circle too bulky or noisy.
- Two nurses circle uncomfortable or difficult to use.
- Two nurses, engineering control, were used.
- One nurse, general room ventilation was sufficient to dissipate the smoke, exposure was minimal, not provided by the employer, and not permitted by the surgeon.

Looking at just the Years Worked and the responses to Question 3 on the Pre-Education test

Appendix M

Pretest Knowledge

PreScore

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	8.00	1	10.0	10.0	10.0
	10.00	2	20.0	20.0	30.0
	11.00	2	20.0	20.0	50.0
	12.00	3	30.0	30.0	80.0
	13.00	1	10.0	10.0	90.0
	14.00	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

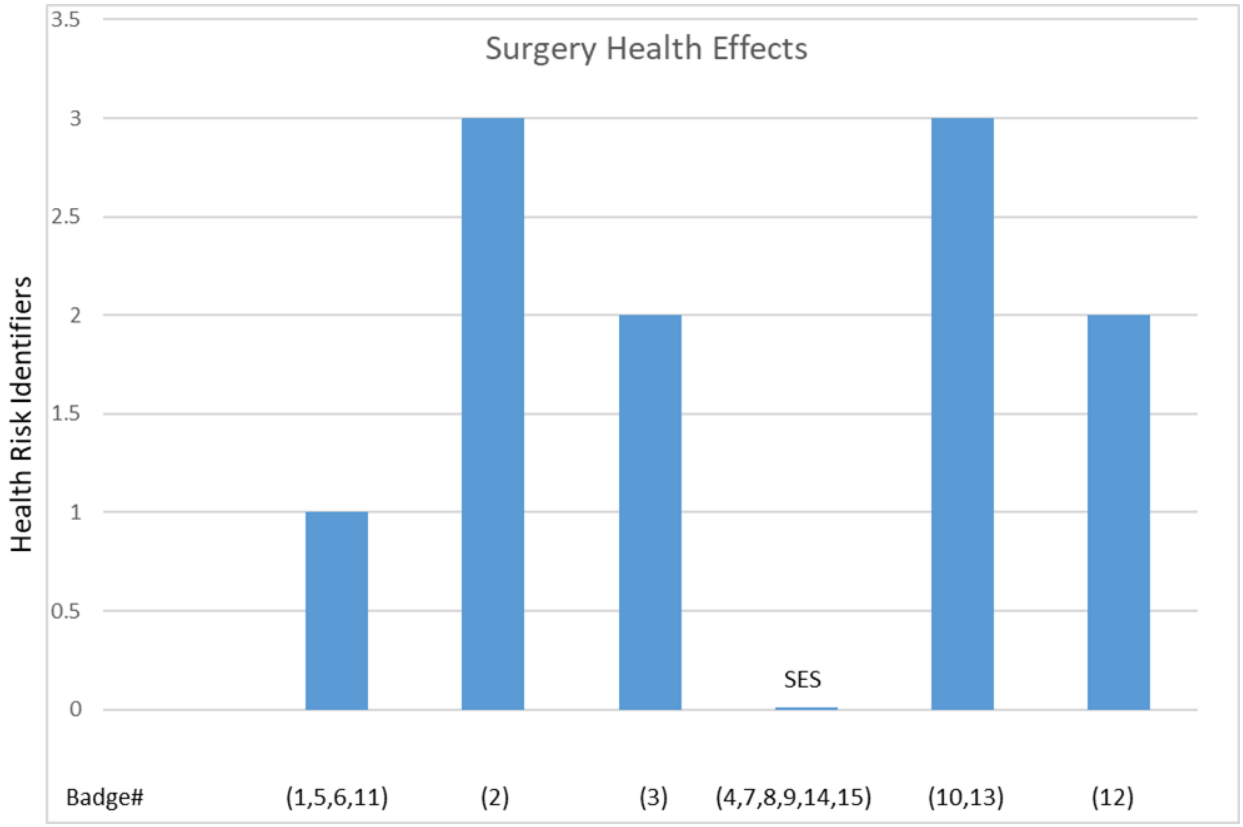
Posttest Knowledge

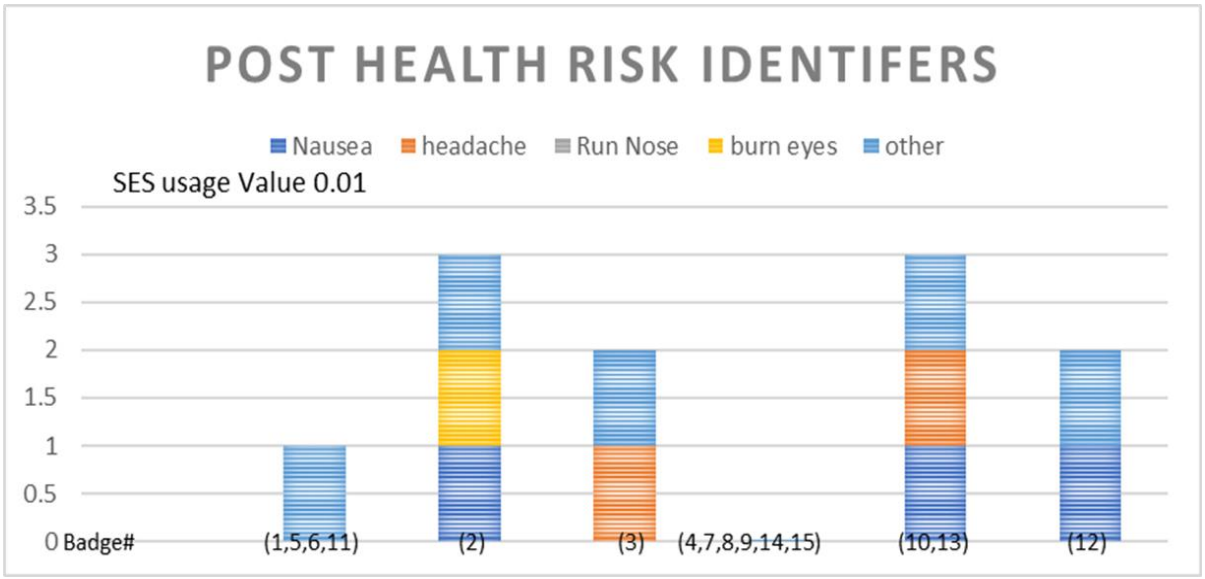
PostScore

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	13.00	2	20.0	20.0	20.0
	14.00	8	80.0	80.0	100.0
	Total	10	100.0	100.0	

Appendix N

The results of the health card survey show in real-time the effects of smoke in the OR displayed in a column graph.





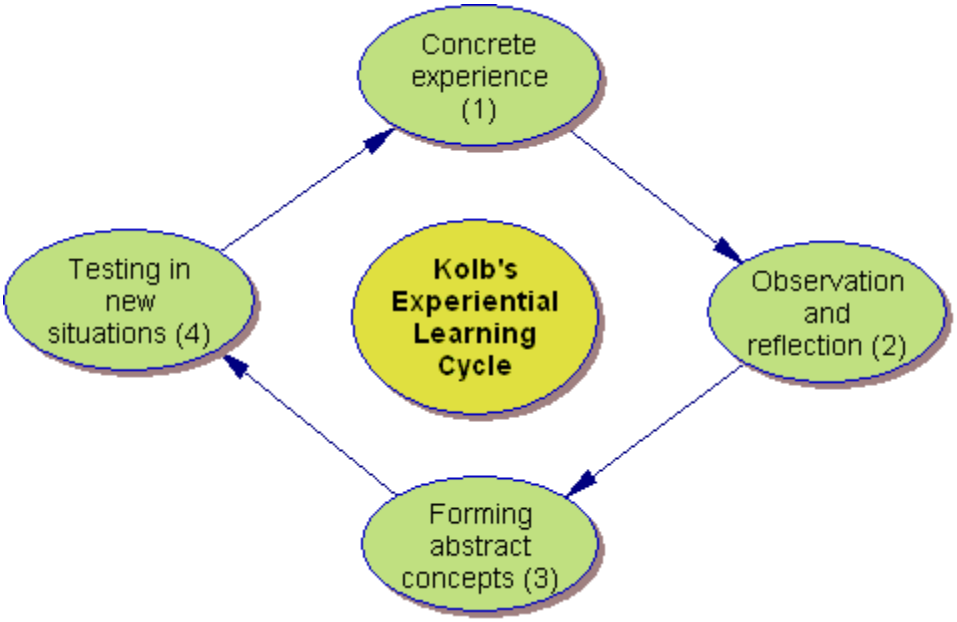
Appendix O

Tracking Real-Time Health Effects

	Health Card Table								
		Time	SES Y/N	Type	Nausea	headache	Run Nose	burn eyes	other
BADGE #	in	out		C/T/W					
1	7:30	8:35	N	0	0	0	0	0	1
2	9:00	10:30	N	0	1	0	0	1	1
3	9:00	10:30	N	0	0	1	0	0	1
4	8:00	10:00	Y	1	0	0	0	0	0
5	11:30	1:00	N	0	0	0	0	0	1
6	1:00	2:10	N	0	0	0	0	0	1
7	7:30	10:00	Y	1	0	0	0	0	0
8	9:30	10:15	Y	1	0	0	0	0	0
9	7:30	10:30	Y	1	0	0	0	0	0
I10	7:30	10:00	N	0	1	2	0	0	1
11	1:00	5:00	N	0	0	0	0	0	1
12	10:20	11:45	N	0	1	0	0	0	5
13	7:30	9:00	N	0	1	1	0	0	5
14	7:30	8:30	Y	1	0	0	0	0	0
15	7:30	9:00	Y	1	0	0	0	0	0

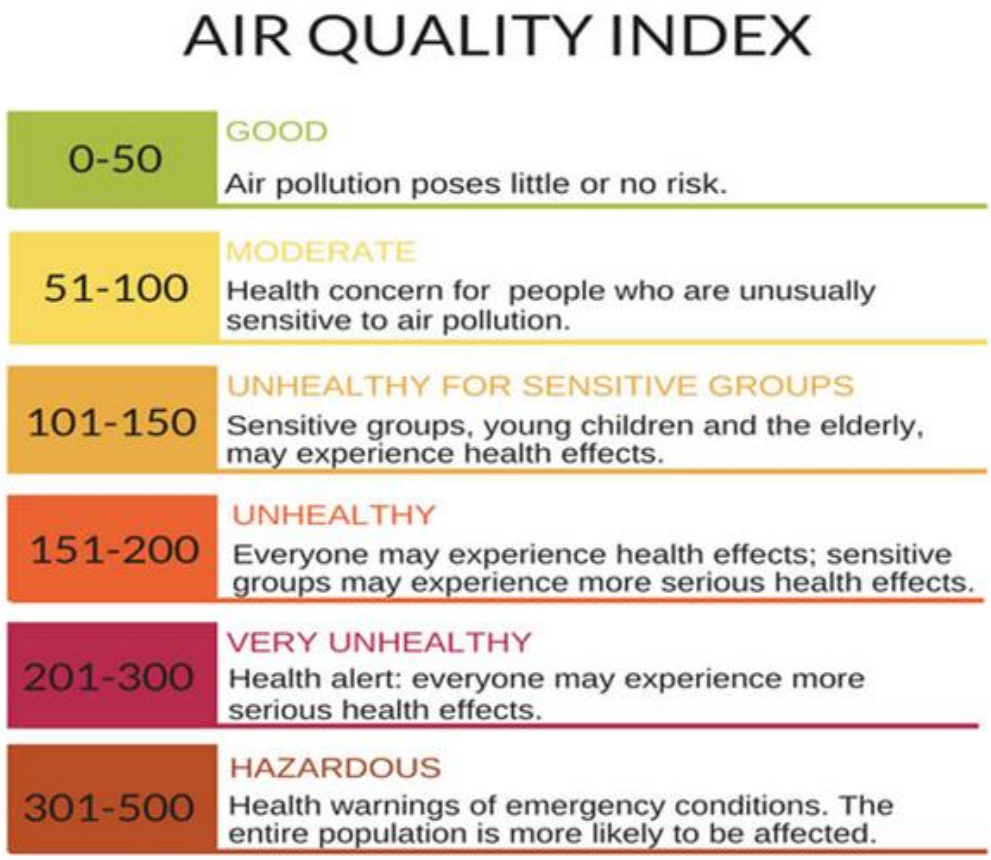
Appendix P

Kolb Theory (1984)



1. Concrete experience (“DO”) is where the learning actively experiences activity in fieldwork
2. reflective observation (or "OBSERVE") when the learner consciously reflect back on that experience
3. abstract conceptualization (or "THINK") where learner attempts to conceptualize what observed
4. active experimentation (or "PLAN") where the learner is trying to plan how to test forthcoming experience

Appendix Q


AIR QUALITY INDEX
0-50
GOOD
Air pollution poses little or no risk.
51-100
MODERATE
Health concern for people who are unusually sensitive to air pollution.
101-150
UNHEALTHY FOR SENSITIVE GROUPS
Sensitive groups, young children and the elderly, may experience health effects.
151-200
UNHEALTHY
Everyone may experience health effects; sensitive groups may experience more serious health effects.
201-300
VERY UNHEALTHY
Health alert: everyone may experience more serious health effects.
301-500
HAZARDOUS
Health warnings of emergency conditions. The entire population is more likely to be affected.

Appendix R

POLICY AND PROCEDURE FOR SMOKE EVACUATION SYSTEM

Purpose: To control the smoke in the operating room with a smoke evacuation system (SES) when electrocautery devices are used, and to minimize the health risk to the OR staff that are exposed to the surgical smoke plume.
Policy Statement: The SES is to capture the toxic hazard gases, vapors, and airborne contaminants that smoke generates by the use of electrocautery devices. The use of the SES will protect patients and healthcare providers from the toxic, hazardous material smoke produce by the electrocautery devices. The hazard smoke plume generated during surgical procedures must be captured and filtered through a smoke evacuator system (SES).

Examples of surgical procedures, but not limited to, which generates large amounts of the smoke plume include:

_ Orthopedic Total Joints
_ Spinal Fusions
_ Fracture Hips procedure
_ Spinal Fusions
_ Scoliosis

Setup:

- Smoke Evacuation Pencil, Electrosurgical Pencil with a smoke Evacuation Tubing attachment or Corrugated Smoke Evacuation Tubing will be connected directly to the Smoke Evacuation System/SES.
- The selected tubing option will be positioned close to the point of surgical plume orientation for the sole purpose of smoke plume evacuation and filtration only.
- The standard suction tubing will be used for fluid evacuation only.

Smoke Evacuation System General Guidelines and Maintenance:

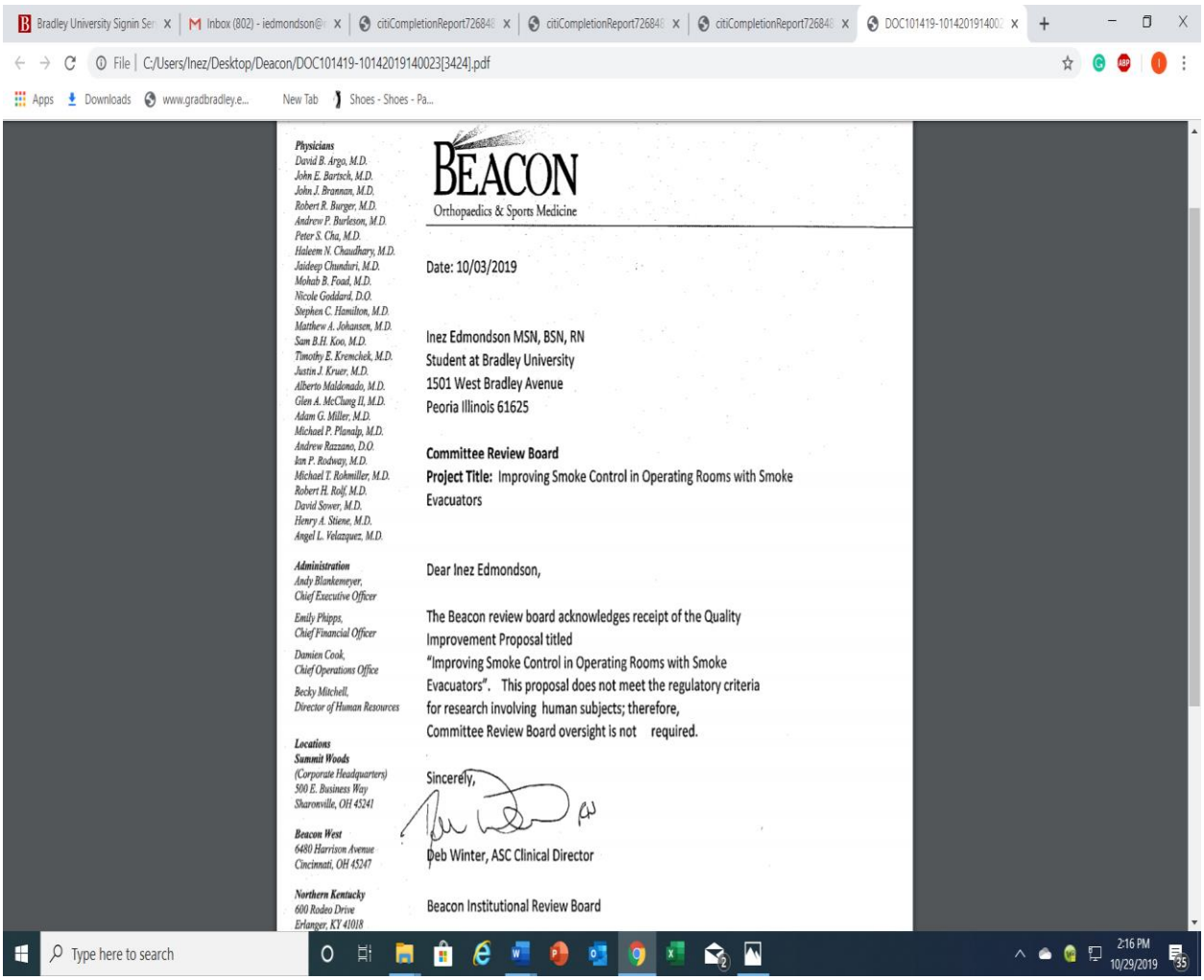
- Ultra-Low Particulate Air (ULPA) Smoke Evacuator **Must** be used on **ALL** procedures producing smoke or laser-generated airborne contaminants.
- Examine the SES unit to ensure that the filter is appropriately loaded.
- Position SES unit for maximum effectiveness, depending on the surgical procedure.
- An adaptor (generic) or smoke pencil may be used on the electrosurgical unit (ESU) active electrode handpiece.
- Straight tubing may be secured close (within 2cm) to the working area to evacuate plume effectively.
- Avoid direct contact with the patient's skin.
- When using the smoke evacuator pencil with the ESU, the unit will be equipped with a remote switch to activate when the ESU is operating. When used with the laser, the foot pedal for the smoke evacuator system should be activated by the surgeon or laser operator.

- Adjust the setting and vacuum intensity as needed depending on the amount of plume.
- After the surgical procedure, replace the smoke evacuator filter according to the manufacturer's instructions for use (IFU).
- Place the filter in a red biohazard bag for disposal per the IFU or at the nurse's discretion when it is visibly soiled.

References

Centers for disease control and prevention (2014). Control of smoke from laser/electric surgical procedures. In NIOSH-Numbered Publications. Retrieved from http://www.cdc.gov/niosh/docs/hazardcontrol/hc11.html

Appendix S



Physicians
David B. Argo, M.D.
John E. Bartsch, M.D.
John J. Brannan, M.D.
Robert R. Burger, M.D.
Andrew P. Burleson, M.D.
Peter S. Cha, M.D.
Haleem N. Chaudhary, M.D.
Jaideep Chunduri, M.D.
Mohab B. Foad, M.D.
Nicole Goddard, D.O.
Stephen C. Hamilton, M.D.
Matthew A. Johansen, M.D.
Sam B.H. Koo, M.D.
Timothy E. Kremchek, M.D.
Justin J. Kruer, M.D.
Alberto Maldonado, M.D.
Glen A. McClung II, M.D.
Adam G. Miller, M.D.
Michael P. Planalp, M.D.
Andrew Razzano, D.O.
Ian P. Rodway, M.D.
Michael T. Rohmiller, M.D.
Robert H. Rolf, M.D.
David Sower, M.D.
Henry A. Stiene, M.D.
Angel L. Velazquez, M.D.

Administration
Andy Blankemeyer,
Chief Executive Officer

Emily Phipps,
Chief Financial Officer

Damien Cook,
Chief Operations Office

Becky Mitchell,
Director of Human Resources

Locations
Summit Woods
(Corporate Headquarters)
500 E. Business Way
Sharonville, OH 45241

Beacon West
6480 Harrison Avenue
Cincinnati, OH 45247

Northern Kentucky
600 Rodeo Drive
Erlanger, KY 41018

BEACON
Orthopaedics & Sports Medicine

Date: 10/03/2019

Inez Edmondson MSN, BSN, RN
Student at Bradley University
1501 West Bradley Avenue
Peoria Illinois 61625

Committee Review Board
Project Title: Improving Smoke Control in Operating Rooms with Smoke Evacuators

Dear Inez Edmondson,

The Beacon review board acknowledges receipt of the Quality Improvement Proposal titled "Improving Smoke Control in Operating Rooms with Smoke Evacuators". This proposal does not meet the regulatory criteria for research involving human subjects; therefore, Committee Review Board oversight is not required.

Sincerely,

Deb Winter, ASC Clinical Director

Beacon Institutional Review Board

Appendix T

BRADLEY University

DATE: 21 NOV 2019

TO: Inez Edmondson, Sarah Silvest-Guerrero
FROM: Bradley University Committee on the Use of Human Subjects in Research

STUDY TITLE: Improving smoke control in operating rooms with smoke evacuators
CUHSR #: 88-19
SUBMISSION TYPE: Initial Review

ACTION: Approved
APPROVAL DATE: 21 NOV 2019
REVIEW TYPE: Quality Assurance

Thank you for the opportunity to review the above referenced proposal. The Bradley University Committee on the Use of Human Subject in Research has determined the proposal to be NOT HUMAN SUBJECTS RESEACH thus exempt from IRB review according to federal regulations. The study has been found to be not human subject research pursuant to 45 CFR 46.102(if), not meeting the federal definition related to human subjects. Please note that it is unlawful to refer to your study as human subjects research.

Your study does not obtain information about living subjects through interaction or intervention with subjects nor does it obtain or generate identifiable information about living subjects.

This email will serve as your written notice that the study is approved unless a more formal letter is needed. You can request a formal letter from the CUHSR secretary in the Office of Sponsored Programs.