2022

Decreasing Anesthesia Workstation Contamination: An Educational Module

Krystal Lynn Sanchez
Florida International University, ksanc070@fiu.edu

Decreasing Anesthesia Workstation Contamination: An Educational Module

A DNP Project Presented to the Faculty of the Nicole Wertheim College of Nursing and Health Sciences

Florida International University

In partial fulfillment of the requirements

For the Degree of Doctor of Nursing Practice

By

Krystal Sanchez, BSN, RN

Supervised by

Vicente Gonzalez DNP, CRNA, ARNP

Tamara Brown, CRNA, ARNP

Approval acknowledged DocuSigned by: Jorge Valdes F0E0FDAF17314D5... , DNP Program Chair

Date: _____

Approval acknowledged: DocuSigned by: Charles Buscemi 5D65DFEB12C74F7... , DNP Program Director

Date: _____

Table of Contents

Abstract

Background: Anesthesia workstations are pathogenic organism reservoirs, leading to potential surgical site infections and other hospital-acquired infections (HAI). Bacterial pathogens are transmitted due to contact with bodily fluids, high task density, invasive procedures, and provider error. Therefore, HAIs are preventable and caused by healthcare providers, resulting in increased healthcare costs, mortality, and morbidity.

Methods: A comprehensive study search was conducted using the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Elton B. Stephens Company (EBSCO), and PubMed to identify literature from the past five years that identified various research methods to decrease anesthesia workstation contamination.

Results: This literature review identified five research studies to support this project. In addition, the articles identified methods to reduce anesthesia workstation contamination, decrease adverse patient outcomes, and decrease HAIs.

Keywords: Anesthesia workstation, contamination, infection, anesthesia providers, gloves, barriers, hospital-acquired infections, interventions

Decreasing Anesthesia Workstation Contamination: An Educational Module

PICO Question

Population (P): Anesthesia providers

Intervention (I): Education on the use of various intervention modalities

Comparison (C): No education

Outcomes (O): Decreasing contamination of the anesthesia workstation

Problem Identification

According to the Centers for Disease Control and Prevention (CDC), one in 31 hospitalized patients has at least one hospital-acquired infection (HAI) daily.[1] HAIs are a primary source of preventative illness and pose a safety concern in patient mortality, morbidity, and healthcare costs. Numerous healthcare specialties and locations populate potential HAI risks. Therefore, causes must be identified to reduce the prevalence of HAIs. In anesthesia, patient interaction is a brief period of intense and invasive procedures. Therefore, anesthesia providers must be vigilant in the transmission and contamination of the anesthesia workstation.

The transmission of pathogens and contaminants on the anesthesia workstation occurs perioperatively and between cases due to anesthesia provider contact with bodily fluids, invasive procedures, high task density, and provider error.[2] These provider errors are one of the direct causes identified in the 30-day postoperative surgical site infections, central line infections, bloodstream infections, and ventilator-acquired pneumonia.[2] Surgical site infections (SSI) account for 20 percent of HAIs, making them the second most common nosocomial infection.[3] Although the transmission of bacterial pathogens is inevitable due to human error and variation, reducing

spread will decrease mortality, morbidity, and healthcare costs while improving patient outcomes. This project aims to educate anesthesia providers on the contamination of the anesthesia workstation and interventions to reduce HAIs.

Background

HAIs lead to prolonged hospital admission, poorer patient outcomes, and increased mortality.[4] Anesthesia providers are transmitters due to careless practice, inconsistent use of gloves, high task completion, poor ergonomic design, forgetfulness, performance pressure, and decreased availability of hand hygiene products.[5] Anesthesia providers document on computer systems while wearing dirty gloves after tracheal intubation, extubation, administration of drugs, or insertion of peripheral intravenous (IV) catheters.[6] One of the simplest and most effective approaches to reducing HAIs is effective hand hygiene. Strategies to mitigate perioperative infections include hand hygiene and limiting the anesthesia workstation. Unfortunately, anesthesia providers have demonstrated poor adherence to proper hand hygiene.

Between 20 and 40 percent of HAIs result from cross-contamination via the hands of healthcare personnel, and an additional 20 percent result from other environmental contamination.[4] Healthcare environment settings are a common vector of nosocomial infection. Identified pathogens include methicillin-resistant staphylococcus aureus (MRSA), Clostridium difficile (C. diff), Acinetobacter baumannii, vancomycin-resistant enterococci (VRE), pseudomonas aeruginosa, norovirus, and gram-negative bacteria.[4] These pathogens are located on “high-touch” or “hot-spot” surfaces such as personal healthcare devices, stethoscopes, cell phones, blood pressure cuffs, clothing, faucets, telephones, laptops, iPads, bedrails, computer keyboards, mice, mousepads, the anesthesia machine, and more.[4] Current cleaning practices fail to achieve the

anesthesia workstation's full decontamination. Various interventions have been tested to reduce the prevalence of pathogen contamination. The use of hand hygiene, double gloving, an anesthesia workstation barrier, disinfection wipes, and Ultraviolet-C (UVC) light are a few examples of possible interventions.

Scope of the Problem

According to the Centers for Medicare and Medicaid Services and the Joint Commission, one in three hospitals have insufficiencies in reprocessing and cleaning medical equipment.[8] Categorized amongst the top ten most common compliance issues in the healthcare setting.[8] Causes include a lack of knowledge, training, respect for sterile processing, leadership support, monitoring, oversight, and tracking.[8] Additionally, a deficient culture of safety, unavailable guidelines, facility design, and space may contribute to this deficiency.[8]

Anesthesia providers are responsible for the lowest compliance with hand hygiene recommendations compared to all other medical specialties. Anesthesia providers' hands are frequently contaminated with bacterial pathogens, even preceding patient contact.[9] Anesthesia provider cross-contamination is a source for anesthesia workstation and IV stopcock infectivity.[9] Researchers have identified that transmission of bacteria often occurs in 37 percent of IV stopcocks, leading to increased patient mortality.[9]

Consequences of the Problem

According to the CDC, HAIs in the United States result in direct medical costs of at least 28.4 billion dollars each year.[1] Preventing HAIs would result in savings between 5.7 and 31.5 billion dollars.[1] For example, one central line-associated bloodstream infection (CLABSI) could cost an estimated 16,550 dollars in additional medical costs.[1] Moreover, there are approximately

1.7 million long-term care patients nationally, with 1.6 to 3.8 million infections estimated yearly.[1] Infection in long-term care residents may account for 23,100 to 70,000 deaths annually.[1] Reporting to the state health department is obligatory. Public disclosure of this data guarantees reliable HAI tracking, increasing accountability and compliance.[1]

Although significant decreases in HAIs have occurred over the previous years, an estimated four percent of hospitalized patients are still affected by HAIs.[8] With changes in hospital reimbursement criteria, HAIs are no longer reimbursed.[8] These occurrences invoke a financial burden for providers; thus, this economic disincentive should initiate a more aggressive approach to diminishing preventable infections.[8]

Knowledge Gaps

Despite evident anesthesia-related HAIs, there is a lack of procedural changes. Additionally, some barriers exist in identifying necessary changes to decrease anesthesia-related infections. Diagnosis of HAIs arises several days after anesthesia care.[9] This delay makes it difficult to determine the changes that are needed. Additionally, anesthesia providers perform hand hygiene less than once per hour during a general anesthesia case, while 60 opportunities to perform hand hygiene are available.[9] The highest incidence of anesthesia workstation contamination occurs during induction and emergence of anesthetic care.[9] Obstacles arise when tracking opportunities for hand hygiene, making enhanced compliance challenging.[9] Therefore, individual provider habits carry an additional barrier. Culture in practice typically requires a change in the practice of the group, combined with efforts to reduce anesthesia-related infection.[9]

Institutional cleaning protocols fluctuate widely and are commonly ineffective in eliminating contamination. Infection control epidemiologists refer to the anesthesia workstation as

the "fecal patina in the anesthesia work area."[2] After sterilization and routine cleaning, pathogens are reduced but not eliminated on the anesthesia machine.[2] Best practices fail in full decontamination, conveying an increased risk of cross-contamination.

Proposal Solution

There is currently no "gold standard" for decontaminating the anesthesia workstation between cases. Additionally, hospital resources create disadvantages in regulating contamination protocols. Lastly, anesthesia provider education and adherence to compliance are essential in decreasing incidences of HAI. Double gloving, anesthesia machine barrier devices, UVC light disinfection, and healthcare staff behaviors can reduce anesthesia workstation contamination. Comparing these methods would result in possible solutions to decrease HAIs. Anesthesia providers are responsible for reducing the incidences of preventable illness, requiring further education. Identifying anesthesia-related causes and creating successful interventions would decrease patient mortality, morbidity, and healthcare costs.

Summary of the Literature

The literature review investigates how contamination and spread occur around the anesthesia work area. Second, to analyze which current interventions are available and their efficacy in sanitization. Finally, the third objective is to review alternative interventions for reducing anesthesia workstation contamination.

Search Strategies

Reviewing and analyzing the quality and accuracy of data is fundamental when conducting a systematic review. Scholarly databases ensure validity in beginning research. Three databases

utilized in this systematic review included: EBSCO, CINAHL, and PubMed. Some keywords and phrases searched included: anesthesia workstation, contamination, infection, anesthesia providers, gloves, barriers, HAI, interventions, anesthesia machine, randomized controlled trial, meta-analysis, primary research study, and standard practice. Boolean operators "AND" and "OR" were used to narrow the literature review. To gather a more general search, using Boolean operators such as "contamination OR infection OR hospital-acquired infection" will result in articles encompassing either of these keywords. Instead, searching "anesthesia workstation AND contamination" will create a more focused and detailed search.

Furthermore, evidence-based research should be within the previous five years; filtering articles by year ensured accurate, up-to-date information by classifying articles from 2016 to 2021. Further inclusion and exclusion criteria were needed when numerous articles resulted from the search. Inclusion criteria comprised studies written in English, published within the past five years, and full-text availability. Exclusion criteria encompassed studies that were not anesthesia-focused and did not identify intervention modalities or focus on the clinical problem. Database sources used for research were accessed via Florida International University (FIU) library services. Additionally, sorting through the relevance of the articles, language, and authenticity assisted in collecting research articles relevant to the clinical problem. Finally, only pieces that met the highest research standards were chosen, ensuing five articles for review.

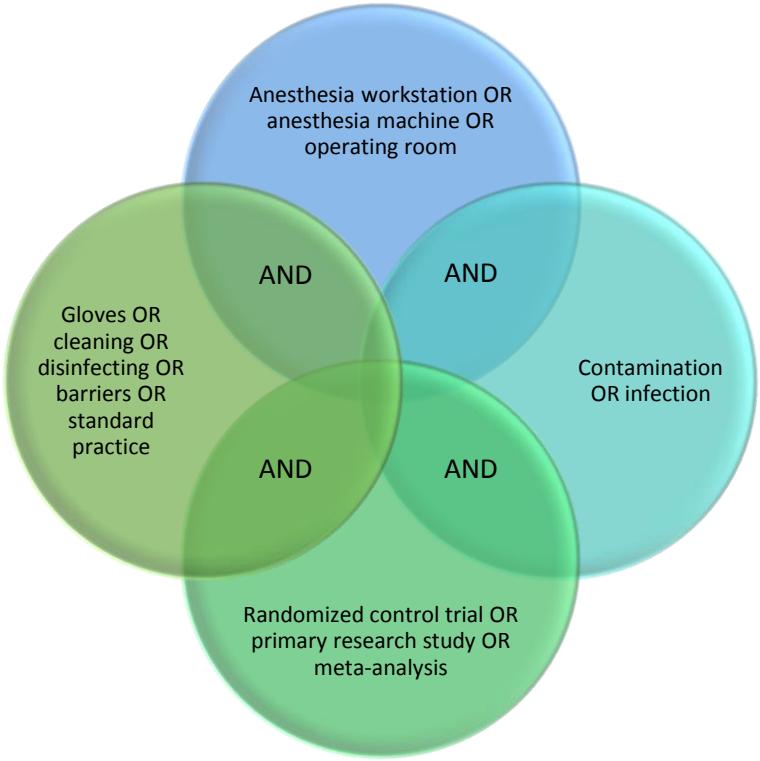


Diagram 1. Search Keywords

Literature Review

Ultraviolet-C Light as a Means of Disinfecting Anesthesia Workstations

This study inspected the effectiveness of the Tru-D SmartUVC device, utilizing a UVC light on bioburden reduction on anesthesia workstations.[10] Inoculated tissue strips were infected with a bacterial pathogen and were placed on 22 high-touch surfaces of an anesthesia workstation.[10] Pathogens included staphylococcus aureus, enterococcus faecalis, or acinetobacter.[10] Half of the surfaces were exposed to direct UVC light, and half were exposed to indirect exposure.[10] Two inoculated strips were used as the control and placed outside the room.[10]

Trials were conducted on anesthesia workstations in an OR and a small room.[10] Strips were placed in a saline solution, vortexed, and placed on blood agar to access bioburden reduction according to the number of colony-forming units.[10] The UVC light device was placed in the middle of the rooms.[10] The UVC lights were operated for approximately 20 minutes in the small rooms and 55 minutes in the large rooms.[10] Each room conducted two runs for a total of four decontamination runs.[10]

After applying UVC light, all organisms in each room demonstrated a reduction in bioburden compared to the other rooms.[10] No differences in decontamination were identified between large or small rooms.[10] Additionally, legitimacy was ensured because the experiment included high-touch surfaces, such as drawer handles, knobs, and dials, that are difficult to clean.[10] This study identified some limitations. First, the true bioburden of organisms on an anesthesia workstation surface is unknown, as is the cross-contamination from patient to patient.[10] Second, the model used for the study employed a "Wypall wipe" that does not impeccably represent the surface of the anesthesia devices assessed.[10] Lastly, the A baumannii and E faecalis control carriers produced an abundance of colonies; thus, the A baumannii control colony-forming units were estimated.[10]

Assessing a Novel Method to Reduce Anesthesia Machine Contamination: A Prospective, Observational Trial

This prospective experimental research design measured the density and diversity of bacterial species found on anesthesia machines after terminal cleaning and between cases during anesthesia care to assess the impact of transparent anesthesia machine wrap (AMW).[2] The AMW

was used in 11 surgical cases and not 11 control surgical cases.[2] Cases assigned were in the general surgical OR.[2]

Anesthesia providers in both groups were unaware of the study to maintain reliability.[2] The provider's machines in the AMW groups came equipped with a wrap, and their insights into its use would be queried at the end of the case.[2] Additionally, the microbial cultures were taken at the end of each case when anesthesia providers were absent.[2] Seven frequently touched and challenging to disinfect anesthesia locations were cultured on each machine before and after each case.[2] These locations included the vaporizer dial, APL valve, mechanical ventilator control knob, patient monitor control panel, oxygen flowmeter control knob, and mouse and keyboard control for electronic medical record documentation.[2] Cultures were taken at each location before the first case, after the anesthesia provider performed the anesthesia machine check and after the completion of each case.[2]

Although there is no set national protocol for cleaning anesthesia equipment, this study assessed the AMW at an organization where the highly trained environmental staff and anesthesia technicians demonstrate strict cleaning and disinfecting processes.[2] The use of OxyCide disinfecting wipes are used at the end of each case and each day.[2] Furthermore, UV light is used in each OR at least once a week.[2]

They used Wilcoxon signed-rank test and Student's t-tests to compare the colony-forming units.[2] As a result, the machines covered with the AMW significantly reduced the overall density of colony-forming units across all hot-spot anesthesia machine locations compared to the control group.[2] The data indicated that the use of the AMW was significantly associated with a decreased incidence of microorganism contamination.[2] There was a significant reduction in the diversity of

colony-forming units across all hot-spot surfaces with the covered AMW, apart from the APL valve.[2] Tracking the density and diversity throughout multiple cases ensured accuracy.[2] An increase in organisms and density over a day in the control room were identified. However, the introduction of bacterial organisms to the anesthesia machine was prevented from patient to patient with the use of the AMW.[2]

It may be beneficial to suggest its use in cases where enhanced protection is warranted and avoid its use in routine care. Patients with known infectious processes such as hepatitis, C-diff., MRSA, or human immunodeficiency virus (HIV) may warrant using an AMW during surgical procedures to decrease the risk of vertical transmission.[2] Some limitations were identified with the AMW use. First, it will not prevent the spread of airborne pathogens.[2] Second, standard cleaning procedures will be successful for macroscopic organisms visible to the naked eye.[2] Third, when removing the AMW, cautionary measures are needed to avoid contaminating the OR.[2]

Assessment of Anesthesia Machine Redesign on Cleaning of the Anesthesia Machine Using Surface Disinfection Wipes

This study assessed an anesthesia machine surface redesign to determine whether anesthesia residents improved disinfection wipe cleaning.[11] The 16 anesthesia residents were assigned to two cases in series.[11] The first case was randomly assigned to a knee or hip surgery. They instructed residents to use a brief or thorough checklist for the Perseus A500 (redesigned) or the GE Aespire 7900 (conventional) machines.[11] In either group, the opposite condition was assigned to the opposite condition.[11]

Eight machine sites were identified in the redesign, contaminated with fluorescent gel before setup, and reassessed after set up to evaluate the disinfection.[11] To denote a previously used

anesthesia workstation, they left items such as a medium-sized oral airway, a Yankauer suction catheter, and an endotracheal tube wrapper with a used stylet.[11] The self-inflating bag was missing, and the suction lid was left unfastened for each case.[11] Setup checklists included detailed cleaning instructions and setup for each case.[11] Residents had three minutes to review the list.[11] After setup was complete and a 30-minute break, residents set up the second case.[11] During the cases and breaks, they secluded the residents from one another.[11]

Photographs were taken of contaminated sites under UV light to obtain fluorescence densitometry readings and compare cleaning before and after the resident's setup.[11] The cleaning of each area was quantitatively assessed by reducing fluorescence.[11] Also, they analyzed replacements of the self-inflating bag and the closure of the suction lid.[11] The second outcome included an assessment of the overall cleaning for each site according to the reduction in fluorescence percentage.[11]

As a result, the cleaning of the Perseus A500 machine showed no significant difference compared to the Aespire 7900.[11] There was a greater incidence of cleaning on the Perseus machine of the manual bag arm, hose, and work surface.[11] Less than 5 percent of most residents cleaned the knobs, dials, switches, and outlets.[11] The median time for cleaning and setup was 7.7 minutes.[11] They identified forgetting the open suction container's lid in 90.6% of the 32 cases and 28.1% of missing self-limiting bags. In all, the preplanned analysis of the eight redesigned surfaces of the Perseus A500 was not associated with improved cleaning. However, the redesigned work surface and manual bag arm and hose of the Perseus A500 machine were associated with enhanced cleaning with surface disinfecting wipes.[11]

Quantifying the Rambunctious Journey of the Anesthesia Provider's Hands During Simulated, Routine Care

In this study, twenty subjects were randomized to a single pair of gloves group (group one) or a double-gloved group (group two). These groups completed a simulated general anesthesia induction, completing a standardized set of interventions.[5] Distribution of a pathogen dye was placed in the oral cavity of the simulated patient and tracked by a blinded observer and photography.[5] Group one was instructed to wear a single pair of gloves throughout the induction period and instantly after successful tracheal intubation before attaching the breathing system to the endotracheal tube.[5] Laryngoscope management was left to the provider's preference and ranged from placing it on the surgical bed, drug supply cart, mannequin's chest, or in a basin attached to the cart.[5] No provider in group one put on a second pair of clean gloves.[5] Group two was instructed to double-glove; immediately after successful intubation, but before attaching the breathing system to the endotracheal tube, the outer gloves were removed and placed, along with the laryngoscope, into a collecting basin attached to the side of the drug supply cart.[5] If the provider did not remove their outer glove at this point, they were instructed to do so.[5]

Participants were unaware of the gel placement on the mannequin's mouth nor why they videotaped their induction sequences.[5] Before each scenario, two research team members scanned the workstation and mannequin with Wood's light to ensure the absence of visible dye from any surface.[5] After completing each scenario, Wood's light scanned the mannequin, anesthesia circuit, supply cart, IV lines, cables, and machine. To inventory the areas of contamination, they used a standard collection tool and took photographs to analyze the results.[5] After each case and data collection, they cleaned the surfaces per the DAZO manufacturer's recommendations.[5] The dye was removed with a light cleaning using soap and water.[5]

As a result, group one contaminated an average of 16 sites compared with group two, which defiled an average of 7.6 sites.[5] Gas flow dials, medication vials, cart drawers, and ventilator controls were significantly contaminated by group one but not by group two.[5] Both groups had similar contamination rates for the airway equipment, roll of tape used to secure the endotracheal tube, breathing system, and IV access ports.[5] Double gloving was associated with less spread of oral fluids to the workstation.[5] Between-case cleaning was ineffective in removing the contaminant, demonstrating that patient-to-patient cross-contamination is indicated.[5]

Use of an Anesthesia Workstation Barrier Device to Decrease Contamination in a Simulated Operating Room

This prospective, randomized control trial assessed 42 unaware attending and resident anesthetists.[12] They instructed the anesthesia professionals to induce and intubate a stimulator prepared with a fluorescence marker in its oral cavity as an indicator of pathogenic organisms.[12] 21 participants were assigned to a control group, while the other 21 performed the stimulation with an AMW.[12]

They provided standard equipment and medications for the induction of anesthesia; all participants wore gloves and performed all tasks up to where the patient would be prepped and draped for surgery.[12] They did not provide antibacterial hand gel nor instruct participants to use the computerized documentation system.[12] A step-by-step simulation sequence was followed in both groups. However, they instructed the intervention group to remove the barrier device during the surgical timeout.[12] 14 target sites were examined with a blacklight and were coded as either not contaminated or contaminated based on the presence or absence of the fluorescent marker.[12] They cleaned the rooms per manufacturer recommendations between simulations.[12]

Rates of contamination were significant between both groups. 44.8 percent of sites were contaminated in the control group, while 19.4 percent were in the barrier group.[12] Contamination also varied depending on the level of training. Interestingly, residents demonstrated a significantly lower contamination rate in the control group than attending anesthetists.[12] In the barrier group, contamination rates were similar between residents and attendings.[12] They found differences in contamination between both groups on the APL valve, ventilator switch, anesthesia workstation, manual ventilation bag, circuit, and IV stopcock.[12] The sites with the highest contamination rates in the control group were the circuit, APL valve, and manual ventilation bag.[12] In the intervention group, the barrier device reduced contamination by roughly two-thirds and roughly half on other sites.[12]

Discussion

Summary of the Evidence

Hand hygiene is the primary intervention in reducing healthcare-associated infections, although compliance remains low.[12] Anesthesia accessibility to hand hygiene supplies remains challenging, and its usage is provider-dependent. Transmission of bacterial pathogens to surgical patients is a significant concern in the OR, and it is the anesthesia provider's responsibility to decrease the incidence of HAIs. Through this literature review, it is evident that additional interventions may reduce anesthesia workstation contamination.

The data collected in the articles described above indicate the gap in the anesthesia workstation and field sanitation. Because hand hygiene tactics remain inaccessible or unused, other potential factors may need implementation. Creating a national protocol for cleaning the anesthesia

workstation would ensure adherence and attainment. Although, limitations arise regarding costs and facility contingency.

These interventions increase initial costs to decrease overall costs related to HAIs and lack of insurance reimbursement. However, UVC light may lower the risk of unnecessary and preventable infections transmitted through the environment. In addition, they are reducing the incidences of HAIs by eradicating the pathogens hidden in healthcare environments, resulting in immediate cost avoidance.[13] Initial investment and maintenance costs of purchasing a UVC light need consideration in its implementation in the OR. Additionally, although covering glove use is considered in healthcare costs, double gloving may slightly increase the healthcare facilities' budget. Lastly, AMW or barriers may be an additional new healthcare cost. Although, as the article recommends, its usage should include patients with known infectious diseases.

Literature Table

Author(s)	Purpose	Intervention(s)/ Measures	Sampling/Setting	Primary Results	Relevant Conclusions
Nottingham M, Peterson G, Doern C, et al.	Assess the use of UVC light as a means of disinfecting anesthesia workstations.	Strips of tissue inoculated with concentration of Staphylococcus aureus, Enterococcus faecalis, or Acinetobacter were placed on 22 high-touch surfaces on an anesthesia machine. Half received direct UVC light, and half received indirect light.	Trials were conducted in an operating room and a small room.	Compared to the controls, all trials exhibited a bioburden reduction of> 99%. There was a more significant reduction of E faecalis colony-forming units under direct exposure than under indirect exposure.	Regardless of the room size or exposure type, UCV greatly influenced bioburden reduction on anesthesia workstation high-touch surfaces.
Biddle CJ, George-Gay B, Prasanna P, et al.	Assess the use of an anesthesia machine wrap to decrease microbial contamination on the anesthesia machine.	Anesthesia machine wraps were placed on anesthesia machines in 11 selected operating rooms where general anesthesia was provided to adult patients undergoing open abdominal surgery. There were 11 operating rooms left absent as the control group.	Cultures were conducted on “hot spot” locations on the anesthesia machines before the case, prior to cleaning, and after cleaning the anesthesia machines.	The anesthesia machines covered had significant reductions in colony-forming units compared to the uncovered anesthesia machines.	Despite thorough cleaning, the anesthesia machine remains a reservoir of bacterial species. Intraoperative use of an AMW shows a significant decrease in colony-forming units.
Schmidt E, Dexter F, Herrmann J, et al.	Assess the use of disinfection wipes on anesthesia workstations by	16 anesthesia residents were assigned two cases. They were provided with detailed setup checklists and cleaning instructions. Eight machines	The Perseus A500 or GE Aespire 7900 machines were used. They were assigned to	Overall, the number of sites cleaned did not differ between machines. Improved cleaning was observed for the work	The number of sites cleaned overall did not differ between machines.

	anesthesia residents.	were contaminated with fluorescent gel prior to the setup and reassessed after setup to assess cleaning.	knee or hip surgery.	surface and manual bag arm/hose of the Perseus machine.	
Biddle CJ, Robinson K, Pike B, et al.	Assess the efficacy of double gloving in stimulated general anesthesia induction.	20 subjects were assigned to either a single-glove group (group one) or a double-glove group (group two). Dispersion of a pathogen dye was placed on the oral cavity of the stimulated patient and was assessed using an observer and photography. Standard cleaning was conducted after each stimulation.	Group two used double gloves, and immediately after successful intubation, but before attaching the breathing system to the endotracheal tube, the outer gloves were removed and placed, along with the laryngoscope, into a collecting basin attached to the side of the drug supply cart.	Group one contaminated an average of 16 sites, while group 2 contaminated an average of 7.6 sites. Cart drawers, gas flow dials, medication vials, and ventilator controls were significantly contaminated by group one but not group two.	The double-gloving technique was associated with less spread of oral inoculum to workstations. Routine cleaning between cases was ineffective in removing the contaminant.
Hunter S, Katz D, Goldberg A, et al.	Assess the use of an AMW in stimulated operating room.	42 attending and resident anesthetists were unaware of the study design and were asked to induce and intubate a stimulated patient who was prepped with fluorescent dye in the oropharynx. 21 participants	They stimulated operating rooms with a human simulator.	44.8% of sites were contaminated in the control group versus 19.4% of sites using the AMW.	Application of an AMW to the anesthesia workstation during intubation might reduce contamination in the intraoperative environment.

		were in the control group, while 21 performed intubation using an AMW on the anesthesia machine.			

Primary DNP Project Goal

Gram-negative organisms are a significant source of contagion and community spread, causing HAIs and bacterial resistance.[14] Environmental contamination of the intraoperative workstation may include antibiotic-resistant pathogens such as MRSA, VRE, and C-diff.[15] Bacterial cross-contamination plays an essential role in HAI development. Still, the significance of the known hospital bacterial reservoirs (health care provider hands, patient, environment, and health care equipment) in this process is unknown.[16] Multifactorial causes of HAIs are prevalent concerning the anesthesia workstation and the anesthesia provider.

Between patient stays, only 50% of hospital surfaces are cleaned sufficiently.[17] The anesthesia provider must take responsibility and accountability to reduce the spread and contamination from anesthesia care perioperatively. Ways to reduce contamination of the anesthesia workstation from patient to patient may include using an anesthesia workstation cover, double gloving, or UV light decontamination. These interventions have been tested for their efficacy in disinfecting the anesthesia workstation to reduce the incidence of HAIs.

No current standard of practice is used in the healthcare field for disinfecting the anesthesia workstation. Identifying the successful interventions in decreasing cross-contamination will direct the creation of a generalized protocol. The primary goal is to create a protocol used by the healthcare field to reduce the spread of HAIs. The objective is to examine which interventions are currently in use and replace them with evidence-based guidelines to decrease the spread of HAIs.

Goals and Outcomes

The "SMART" acronym is a guide used to define goals and outcomes to close current practice gaps.[5] The acronym details that the objectives should be specific, measurable, achievable,

realistic, and timely.[18] Each framework element works together to create carefully planned and attainable goals.

Specific

After each surgical patient case, environmental services, anesthesia technicians, and anesthesia providers will follow a standardized cleaning protocol. In addition, they will utilize tools such as double gloving and an anesthesia workstation barrier device in each case.

Measurable

Stakeholders will measure the effectiveness of a standardized cleaning protocol by culturing the anesthesia workstation "hot spots" before its initiation and after. Outcomes will be measured by evaluating the number of HAIs before and after initiating the protocol.

Achievable

Environmental services, anesthesia technicians, anesthesia providers, nursing informatics, and surgical service management will develop the standardized protocol.

Realistic

Stakeholders will educate anesthesia personnel on the new protocol, double gloving, and the anesthesia barrier device. In addition, they will educate environmental services on UVC light decontamination in-between cases.

Timely

Stakeholders will complete the perioperative anesthesia workstation decontamination protocol, which will be available to staff within four months.

Program Structure

Developing a perioperative anesthesia decontamination protocol will require a collaborative, multi-disciplinary team effort. First, a comprehensive assessment will determine the guidelines and gaps in the healthcare system. Then, the strength, weakness, opportunities, and threats (SWOT) analysis tool will guide changes to improve patient outcomes.

Expect stakeholders from various disciplines will be required to create the protocol. The expert stakeholders will be from different fields. They will assist in decreasing perioperative anesthesia cross-contamination and developing an educational intervention module for anesthesia providers and environmental services. The staff will be provided with a questionnaire to measure their knowledge of the current guidelines and practices, the most common HAIs encountered perioperatively, and the "hot-spot" locations on the anesthesia workstation. Participants will then be provided an educational module with a blueprint of the new changes in the healthcare system to decrease anesthesia workstation contamination and the spread of HAIs. The staff will receive an online module. After the education modules, staff will complete a survey assessing their knowledge of the changes and expected outcomes.

Strengths

The strengths identified in developing this protocol are beneficial across several departments. First, the creation of the protocol would decrease the spread of HAIs. According to the Centers for Medicare and Medicaid Services, for discharges occurring after October 1, 2008, hospitals will not receive reimbursement for cases involving infections that were not present during patient admission.[19] The creation of this protocol would decrease hospital costs due to reducing the incidence of related surgical infections and additional preventable hospital stays.

Additionally, reducing the spread of HAIs would result in better patient outcomes, decreasing mortality and morbidity.

The education of the staff is another identified strength. Educating the anesthesia providers on the most associated sites with the highest contamination will encourage adherence to decrease cross-contamination. The education module will also support the decreasing spread of infection to hospital staff, as these areas are often in contact with staff without gloves. Lastly, this education module will result in a more informed environmental staff, benefitting the patients and the staff equally.

Weakness

Weaknesses in a program may include internal traits that could be harmful and disrupt the disposition.[18] This may interfere with the ability of the program to meet its objectives.[5] The costs of double gloving and anesthesia machine covers may hinder compliance with the protocol. In addition, the program's success depends on the staff involved. Due to this requirement, there may be additional limitations. Due to short staffing in the healthcare system, staff may be rushed during and between surgical cases, resulting in a further gap in the program.

Additionally, measuring the success of the outcomes of the implemented protocol may take time and effort. Although HAIs are accounted for in the healthcare system, correlating these infections directly to surgical procedures is assumed. It is challenging to correlate when or what caused the infection. Thus, weaknesses in measuring the protocol's efficacy may need to be more accurate.

Opportunities

Implementing a decontamination protocol would bring about potential opportunities throughout the healthcare system. The collaboration necessary to create the change would allow opportunities to unite and identify other needed modifications within the system. Listening to other staff members may surface potential for additional gaps. This collaboration is beneficial in determining which changes are necessary and where budgeting fulfillment is required.

With the decrease in HAIs and costs, supplies and tools may be disseminated. The reduction in HAIs would be a remarkable opportunity for the patient population. Decreasing morbidity and mortality throughout the community would result in healthier patients and decrease unnecessary adversaries. This education module educates the staff and identifies additional needs. By communicating with the staff, other options or ideas may arise.

Threats

Factors that may harm the process or interfere with the program's ability to achieve its objectives must be examined, for if unaddressed, they may cause catastrophic outcomes.[18] The weaknesses identified bring upon potential threats in the development and initiation of the protocol. For example, the staff may be a threat to the change. In addition, adherence to the protocol is staff-dependent. Thus, to ensure compliance, systems need an accountability program.

An additional obstacle may involve the initial presentation to the stakeholders to persuade them why the change is needed and will benefit the system. Locating the primary stakeholders may be a potential threat. Picking the best and most appropriate stakeholders is vital to the success of the change. Lastly, the gap inaccuracy in measuring the decrease in HAIs is a significant threat. The inconsistency will result in a discrepancy in the execution of the protocol.

Organizational factors

A collaborative team approach will develop the implementation of the decontamination protocol. First, the stakeholders will be identified and educated on the gap recognized in practice. Next, they will develop a decontamination protocol. Then, stakeholders will analyze data to determine how many HAIs are currently surgically associated. Additionally, the costs needed to initiate the changes need to be acknowledged. Finally, surveys will be analyzed after introducing the protocol to the staff to determine if further education is required. Gathering this information will ensure success when being implemented.

Another analysis will be completed after six months of the protocol being in effect. Again, stakeholders will be responsible for sorting through the data and creating a report. This report will identify the details of the protocol, interventions used, the purpose statement, methods, the background about the clinical issues, tools used to collect data, interpreted data, conclusions and findings after implementation, unexpected outcomes, limitations, and further recommendations.

Definition of Terms

Decontamination

According to the United States Department of Labor Occupational Safety and Health Administration (OSHA), *decontamination* is defined as the "process of removing or neutralizing contaminants that have accumulated on personnel and equipment.[20]

Perioperative

The National Cancer Institute defines *perioperative* as "around the time of surgery."[21] Usually lasting from when the patient is in the preoperative state to when the patient goes home.[21]

Cross-contamination

The Merriam-Webster dictionary states *cross-contamination* is the "inadvertent transfer of bacteria or other contaminants from one surface, substance, etcetera, to another, especially because of unsanitary handling procedures."[22]

Hospital-Acquired Infections

According to the United States Department of Health and Human Services, *HAIs* "are infections people get while receiving health care for another condition."[23] These HAIs may include CLABSI, catheter-associated urinary tract infections (CAUTI), SSI, or ventilator-associated pneumonia (VAP).[12]

Conceptual Framework

A conceptual framework can connect all the critical aspects of a project.[18] The Donabedian model will focus on the project's structure, process, and outcome.[18] The main categories will help organize the project's delivery. First, the design involves the setting in which the project will occur.[18] The project's setting is an online module. Second, completion of the process and how it will be delivered.[18] The process is the educational module provided through education to the hospital staff. Lastly, the outcome is what was measured, reviewed, or assessed.[18] The product is measured by the change in education gained by the staff as indicated through results obtained.

Methodology

Setting and Participants

This study will take place online by gathering information from anesthesia providers through a pre and post-test. The participants will be the anesthesia providers employed at the healthcare facility.

Description of Approach and Project Procedures

The DNP project's intervention will invite the staff members to an education seminar. A pre-test will evaluate the knowledge of the staff. They will collect data regarding their position, years in practice, history of previous cross-contamination training, and current understanding of the subject. The educational program will contain information regarding the prevalence of HAIs, the typical "hot spots" for contamination in the anesthesia workstation, the pathogens commonly associated with HAIs, the interventions projected to decrease the incidence, and the effectiveness of implementing these interventions. The educational program will last around ten minutes. After the educational seminar, a post-survey will determine if further education is needed or assess additional gaps. Staff will be encouraged to speak openly regarding their questions and concerns.

Protection of Human Subjects

All staff involved in the trial will sign consent forms. After approval from the Institutional Review Board, Health Insurance Portability and Accountability Act (HIPAA) will protect the personnel involved in the trial. Participants may feel free to withdraw from the trial at any time. The benefits of participating in the trial include provider education and decreasing the spread and incidence of HAIs. No identifier information will be utilized in the data collection, although indirect identifiers may organize information.

Data Collection

Participants will provide identifier and demographic data. In addition, a consent form will detail the trial process and documentation data. Data will be collected and tracked through the online database known as Qualtrics.

Data Management and Analysis Plan

An Electronic database system will store the data in a password-locked laptop computer. No direct identifiers will be used during the investigation to maintain participant discretion. After two weeks, results will be collected, and data will be analyzed. Comparisons will be made regarding the improved knowledge of the anesthesia staff.

Discussion of Results with Implications to Advanced Nursing Practice

It is hypothesized that this study will result in a decrease in an increase in education from the anesthesia staff. This information would directly reduce costs for the healthcare system, improve patient outcomes, and decrease the spread of infection to staff directly. The results of this study would affect anesthesia personnel directly, and its implications may extend throughout other healthcare systems. In addition, the effectiveness of the education program may result in further change or identifying additional gaps in practice. Many of the previous studies in the literature are conducted in a stimulating setting or with student participants. By implementing it into practice, statistical data may be extracted.

Timeline

1. Develop the educational module
2. Develop a pre-education questionnaire
3. Develop a post-education survey
4. Choose an electronic database
5. Submit a request for approval from the institutional review board
6. Write a consent form

7. Create the educational program invitation
8. Dispense the pre-education questionnaire
9. Conduct the educational presentation
10. Dispense the post-education survey
11. Review the data
12. Analyze data

Project Timeline

Results

After the educational module was created and finalized, the anesthesia staff was contacted via email, asking to review the educational module. A consent form was provided prior to completing the module. The module included a pre-test survey, an educational module, and a post-test survey. The module was open for two weeks for completion by the staff.

Pre-Test Demographics

The educational module pre-test demographics are outlined below in Table 1. It is important to note that the post-test demographics are identical to the pre-test demographics; an

anonymous link redirected the participant to the post-test for completion following the educational module.

Table 1

Pre-Test Participant Demographics

Demographic	***n* (%)**
Total Participants	4 (100.00%)
Gender	
Male	1 (25.00%)
Female	3 (75.00%)
Age	
20-30	1 (25.00%)
30-40	2 (50.00%)
50-60	1 (25.00%)
Ethnicity	
Caucasian	3 (60.00%)
African American	1 (20.00%)
Position/Title	
CRNA	3 (75.00%)
Anesthesiologist	1 (25.00%)
Level of Education	
Doctorate	3 (75.00%)
Master	1 (25.00%)
Experience as an Anesthesia Provider	
10 years or more	1 (25.00%)
1-2 years	3 (75.00%)

There were four participants (*n*= 4) in this study. As anticipated, most participants were female (*n*= 3, 75.00%), compared to male (*n*=1, 25.00%). In addition, participants were in the following age range: age 20-30 (n=1, 25.00%), age 30-40 (n=2, 50.00%), and age 50-60 (n=1, 25.00%). Furthermore, the ethnicities of the participants in this study varied: African American (n=2, 50.00%) and Caucasian (n=2, 50.00%). As expected, CRNAs represented most participants (*n*=3, 75.00%); one participant was an anesthesiologist (*n*=1, 25.00%). In addition, three participants reported a doctorate level of education (*n*=3, 75.00%), while one reported a master's level (*n*=1, 25.00%). Lastly, the representatives were questioned about their experience in the field, which demonstrated the following: 1-2 years (*n*=3, 75.00%), ten years or more (*n*=1, 25.00%).

Pre-Test Knowledge of Anesthesia Machine Contamination

This section contains questions that assess the participant's knowledge of the contamination of the anesthesia machine. The first question assessed their knowledge of the percentage of surgical site infections associated with HAI. Two participants (50.00%) correctly answered the question. 20% of surgical site infections are related to HAI, while one participant (25.00%) stated 40% and one participant (25.00%) chose 60%. All the participants (100.00%) answered the second question correctly. They understood that hand washing is the most effective approach to reducing HAIs.

Next, participants were assessed on their knowledge of the best cleaning products used in the OR. In a true or false question, participants chose whether full decontamination was achieved utilizing current cleaning products. Three participants (75.00%) answered correctly, choosing true, while one (25.00%) chose false. All participants (100.00%) answered the fourth question

correctly, stating that the medical specialty with the lowest hand hygiene compliance indicated anesthesia providers as the correct answer.

Participants were provided with a true or false question next. All the participants (100.00%) chose true correctly, indicating that reporting HAIs to the state health department is obligatory and public disclosure of the data is available. All the participants (100.00%) understood how often anesthesia providers perform hand hygiene. The participants understood that hand hygiene is performed less than once per hour during a general anesthesia case.

The next question indicated choosing one correct answer. However, the participants needed to understand that the two responses were correct. Thus, the question asked to choose when the highest incidence of anesthesia workstation contamination occurs. Three participants (75.00%) chose that this occurred during induction, while one participant (25.00%) chose that this occurred during peripheral intravenous insertion. The other correct response was during emergence, which no one chose.

Participants were evaluated on their knowledge of using ultraviolet light for decontamination. Two participants (50.00%) understood that UV light is used for terminal cleaning the OR between and after cases, while two participants (50.00%) demonstrated a knowledge gap. They chose incorrectly, stating that UV light decontaminates small surgical tools. Next, participants were evaluated on their understanding of the anesthesia machine wrap. Three participants (75.00%) understood that the AMW is disposable and protects the anesthesia machine. One participant (25.00%) chose that it separates the operative field from the anesthesia workstation.

Lastly, participants were evaluated on their knowledge of the use of double gloving by anesthesia providers upon induction. Half of the participants (50.00%) understood that doubling gloving by anesthesia providers has not shown an increase in the spread of oral secretions in the anesthesia work area. The other two participants (50.00%) suggested a knowledge gap.

Post-Test Knowledge of Anesthesia Machine Contamination

This section incorporates data regarding the participants' knowledge of anesthesia machine contamination after the educational module was provided. Table 2 illustrates the differences in responses from the pre and post-tests and the improvement percentage.

Table 2

Difference in Pre and Post-Test

True Responses	*Pre-test*	*Post-test*	*Difference*
Surgical site infections account for what percentage of hospital-acquired infections?	50.00%	50.00%	**0.00%**
The most effective approach in reducing hospital-acquired infections includes:	100.00%	100.00%	**0.00%**
Current cleaning products fail in achieving full decontamination of the anesthesia workstation; true or false?	75.00%	75.00%	**0.00%**
Which medical specialty is amongst the lowest compliance with hand hygiene?	100.00%	100.00%	**0.00%**
Reporting hospital-acquired infections to the state health department is obligatory and public disclosure of the data is available; true or false?	100.00%	100.00%	**0.00%**
Anesthesia providers perform hand hygiene on an average of:	100.00%	100.00%	**0.00%**
The highest incidence of anesthesia workstation contamination occurs during: (Select 2)	75.00%	100.00%	**25.00%**
Ultraviolet light can be used for:	50.00%	75.00%	**25.00%**
An anesthesia machine wrap:	75.00%	75.00%	**0.00%**
The use of double gloving by anesthesia personnel has shown an increase in spread of oral secretions in the anesthesia work area; true or false?	50.00%	75.00%	**25.00%**

In Table 2, shown above, it was evident that there needed to be an overall improvement in the education of the anesthesia providers participating in the educational module. There was a notable improvement (25.00%) in the participant's knowledge of using UV light for decontamination. There was also a knowledge improvement (25.00%) regarding using double gloving to decrease the spread of oral secretions during induction. Lastly, the "select two" question resulted in an inaccurate response. Participants again only chose one response in the

post-test. As a result, improvements in education were seen as all the participants (100.00%) chose “induction” as the event causing the highest incidence of contamination to the anesthesia workstation. Thus, an improvement in knowledge (25.00%) was seen as “peripheral intravenous insertion” was not the second correct response. None of the participants chose “emergence” during the post-test.

During the post-test, two participants (50.00%) understood that 20% of surgical site infections account for HAIs, while the others (50.00%) chose 60%. Compared to the pre-test, one participant (25.00%) changed their response from 40% to 60%. All participants (100.00%) understood that handwashing is the most effective approach to reduce HAIs in the pre-test and the post-test; therefore, there was no change in knowledge.

No changes were seen as the participants chose the same responses for the true or false question asking if the current best cleaning products fail in achieving full decontamination. Three participants (75.00%) chose true, while one (25.00%) chose false. All participants (100.00%) understood that anesthesia providers are amongst the lowest compliance with hand washing in the pre-test and the post-test; therefore, there was no change in knowledge.

In a true or false question asking if reporting HAIs to the state health department was obligatory, all participants (100.00%) correctly chose true in the pre and post-test; therefore, there was no change in knowledge. In addition, all participants (100.00%) understood that anesthesia providers perform hand washing on average less than once per hour during a general anesthesia case in the pre and post-test; therefore, there was no change in knowledge. Lastly, no changes were seen as the participants chose the same responses asking about using an anesthesia machine wrap. One participant (25.00%) chose that it separates the operative field from the

anesthesia work area, while three participants (75.00%) understood that it is disposable and protects the anesthesia machine.

Summary

Overall, the results reflect that there needed to be a degree of improvement from the pre- to post-educational module assessment. In addition, there remained to be a need for more knowledge and attitude amongst the participating anesthesia providers following the completion of this educational intervention.

Discussion

Limitations

Limitations of this study include the small sample size (n= 4). In addition, this project was delivered to an anesthesia group at a large private hospital. Therefore, a multi-center study incorporating other anesthesia groups would have been ideal and likely strengthen the validity of the study results. Finally, time was an additional barrier to the study, as the candidates had two weeks to complete all phases of the educational module. The researchers believe that an extended timeframe would have solicited greater participation from anesthesia providers, thus, adding value to the project with a larger sample size.

Lastly, the online delivery method of the project may have impacted the overall participation from anesthesia providers due to the asynchronous format and deadline. Six other anesthesia providers completed only the pre-test and not the post-test; therefore, they were

excluded from the study's results. With the four participants included in the study's results, one of the questions included two correct responses, in which participants only chose one answer.

Future Implications for Advanced Practice Nursing

Anesthesia providers are at the forefront in the operating room, managing the patient's status, hemodynamics, and airway. This high-stress and steadfast environment place pressure on the anesthesia provider to be quick while minimizing errors and maintaining sterility as best as possible. The anesthesia provider manages oral and gastric secretions, peripheral IVs, and blood transfusions. Potential contamination of the anesthesia workstation may occur during induction, maintenance, and emergence. With the information gathered from this educational module, further education is evident.

With the rise of coronavirus disease 2019 (COVID-19), concerns about infectivity and standard precautions have heightened. Airway manipulations and intubations increasingly expose anesthesia providers to COVID-19.[23] This virus has highlighted gaps in the healthcare field, necessitating alterations. Although before COVID-19, facemasks were worn in every operating room, healthcare staff have increased their awareness regarding standard precautions and personal protective equipment. In attempts to minimize contamination, recommendations have been altered considering the uncertainty of this virus. In addition, some surgical facilities have implemented a mayo stand in the anesthesia workstation during induction. Supplies used during induction are placed on the mayo stand rather than the anesthesia machine to decrease contamination of the anesthesia machine.

In summary, the evidence from the studies solidified the foundation for this quality improvement (QI) project, which serves as a catalyst to further educate anesthesia providers on

ways to decrease anesthesia workstation contamination. The author of this QI project aimed to bridge the knowledge-to-clinical practice gap among anesthesia providers regarding ways to decrease HAIs associated with anesthesia personnel. The outcomes of this educational intervention are critical to identifying the strategies required to enhance the anesthesia providers' capacity to minimize contamination of the anesthesia workstation.

This educational module explains the anesthesia provider's knowledge of decreasing anesthesia workstation contamination. Overall, the data demonstrate a gap in educational intervention. Therefore, it is prudent to extend and modify the educational module with other clinical settings to initiate a paradigm shift in anesthetic care and decrease the contamination of the anesthesia workstation. Additional research that focuses on the number of anesthesia-associated HAIs and disseminating this educational module to other clinical settings is recommended to validate our findings and prompt a universal practice change.

Appendix A

FIU | FLORIDA INTERNATIONAL UNIVERSITY

Office of Research Integrity
Research Compliance, MARC 414

MEMORANDUM

To:	Dr. Vicente Gonzalez
CC:	Krystal Sanchez
From:	Maria Melendez-Vargas, MIBA, IRB Coordinator
Date:	April 29, 2022
Protocol Title:	"Decreasing Anesthesia Workstation Contamination: An Educational Module"

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the **Exempt Review** process.

IRB Protocol Exemption #: IRB-22-0181 **IRB Exemption Date:** 04/29/22
TOPAZ Reference #: 111396

As a requirement of IRB Exemption you are required to:

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

Special Conditions: N/A

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

MMV/em

Select Approved Protocol

Printed By: Sanchez, Krystal

6/15/2022 2:42:48 PM

Protocol #	Reference #	Protocol Status	Version #	Principal Investigator	Author	Title	Protocol Type	Approval Date	Effective Date	Expiration Date	Renewal Date	Submission Date	Modified Date	Amendment/Renewal In Progress	Parent Protocol #
IRB-22-0181	111396	Approved	1	Gonzalez, Vicente	Sanchez, Krystal	Decreasing Anesthesia Workstation Contamination: An Educational Module	Original	4/29/2022	4/29/2022	4/29/2027	4/29/2027	4/7/2022	4/29/2022	No	

Envision
PHYSICIAN SERVICES

February 1, 2022

Vicente Gonzalez, DNP, CRNA, APRN
Clinical Assistant Professor,
Department of Nurse Anesthesiology
Florida International University

Dr. Gonzalez,

Thank you for inviting Memorial Regional to participate in Doctor of Nursing Practice (DNP) project conducted by Krystal Sanchez entitled "Decreasing Anesthesia Workstation Contamination: An Educational Module." in the Nicole Wertheim College of Nursing and Health Sciences, Department of Nurse Anesthetist Practice at Florida International University. I have warranted her permission to conduct the project using our providers.

Evidence-based practice's primary aim is to yield the best outcomes for patients by selecting interventions supported by the evidence. This project intends to evaluate if a structured education targeting providers will increase knowledge decreasing Anesthesia Workstation Contamination.

We understand that participation in the study is voluntary and carries no overt risk. All Anesthesiology providers are free to participate or withdraw from the study at any time. The educational intervention will be conveyed by a 15-minute virtual PowerPoint presentation, with a pretest and posttest questionnaire delivered by a URL link electronically via Qualtrics, an online survey product. Responses to pretest and posttest surveys are not linked to any participant. The collected information is reported as an aggregate, and there is no monetary compensation for participation. All collected material will be kept confidential, stored in a password-encrypted digital cloud, and only be accessible to the investigators of this study: Krystal Sanchez and Dr. Gonzalez. We expect that Krystal Sanchez l will not interfere with normal hospital performance, behave in a professional manner and follow standards of care.

Prior to the implementation of this educational project, the Florida International University Institutional Review Board will evaluate and approve the procedures to conduct this project. Once the Institutional Review Board's approval is achieved, this scholarly project's execution will occur over two weeks. We support the participation of our Anesthesiology providers in this project and look forward to working with you.

Suzanne Hale 3/8/2021

Suzanne Hale, MSN, CRNA, ARNP
Advanced Practice Provider Director, Broward and Dade
Chief, Memorial Regional Hospital
Envision Physician Services
954-265-2044

Appendix B

Pretest and Posttest Questionnaire:

Decreasing Anesthesia Workstation Contamination

INTRODUCTION

The primary aim of this QI project is to improve the knowledge of anesthesia providers pertaining to decreasing anesthesia workstation contamination to improve patient outcomes in the surgical setting.

Please answer the questions below to the best of your ability. The questions are either in multiple choice or true/false format and are meant to measure knowledge and perceptions on ways to decrease anesthesia workstation contamination.

DEMOGRAPHICS

1. **Gender:**
    a. Male
    b. Female
    c. Other _____
2. **Age:**
    a. 20-30
    b. 30-40
    c. 40-50
    d. 50-60
    e. 60+

3. **Ethnicity:**
    - **a.** Hispanic
    - **b.** Caucasian
    - **c.** African American
    - **d.** Asian
    - **e.** Other _____
4. **Position/Title:**
    - a. Anesthesiologist
    - b. Certified Registered Nurse Anesthetist
    - c. Anesthesia Assistant
    - d. Other _____
5. **Level of Education:**
    - a. Masters
    - b. Doctorate
    - c. Other _____
6. How many years have you been an anesthesia provider?
    - a. Over 10
    - b. 5-10 years
    - c. 2-5 years
    - d. 1-2 years

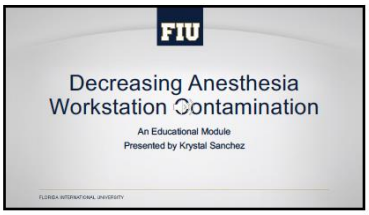
QUESTIONNAIRE

1. **Surgical site infections account for what percentage of hospital acquired infections?**
    a. 20%
    b. 40%
    c. 60%
    d. 80%
2. **The most effective approach in reducing hospital acquired infections includes:**
    a. Using gloves
    b. Hand washing
    c. Scrubbing intravenous catheter ports with an alcohol-based product
    d. The use of personal protective equipment
3. **Current best cleaning products fail in achieving full decontamination of the anesthesia workstation.**
    a. True
    b. False
4. **Which medical specialty is amongst the lowest compliance with hand hygiene?**
    a. Physical therapists
    b. Nurses
    c. Anesthesia providers
    d. Firefighters
5. **Reporting hospital acquired infections to the state health department is obligatory and public disclosure of the data is available.**
    a. True
    b. False

6. **Anesthesia providers perform hand hygiene on an average of:**
    - **a.** Less than once per hour during a general anesthesia case
    - **b.** Less than twice per hour during a general anesthesia case
    - **c.** Less than three times per hour during a general anesthesia case
    - **d.** Less than four times per hour during a general anesthesia case
7. **The highest incidence of anesthesia workstation contamination occurs during: (Select 2)**
    - a. Induction
    - b. Peripheral intravenous insertion
    - c. Maintenance
    - d. Emergence
8. **Ultraviolet light can be used for:**
    - a. Assisting the surgeon
    - b. Decontamination of small surgical tools
    - c. Terminal cleaning of the operating room between and after cases
9. **An anesthesia machine wrap:**
    - a. Is reusable and protects the anesthesia machine
    - b. Separates the operative field from the anesthesia work area
    - c. Is disposable and protects the anesthesia machine
10. The use of double gloving by anesthesia personnel has shown an increase in spread of oral secretions in the anesthesia work area.
    - a. True
    - b. False

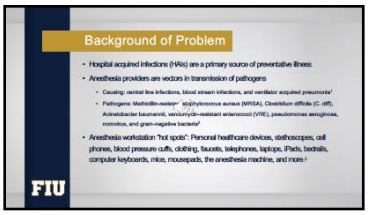
Appendix C

Educational Module

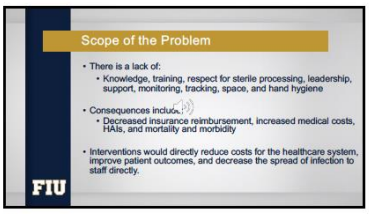


1

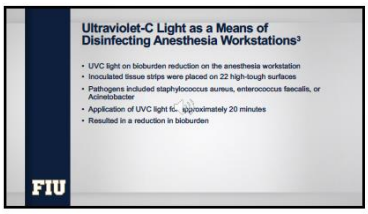
2



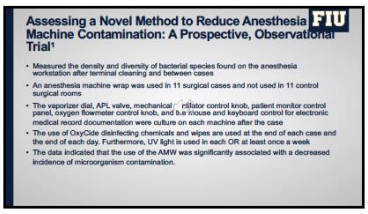
3



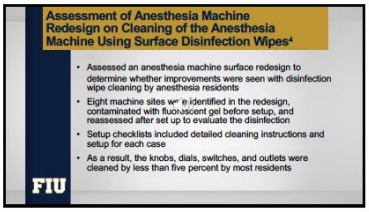
4



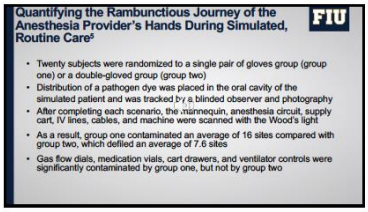
5



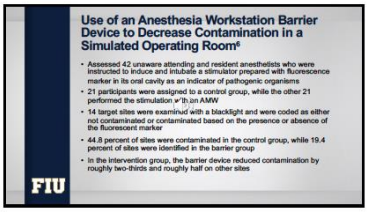
6



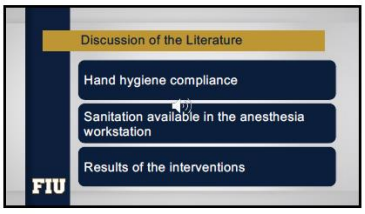
7



8

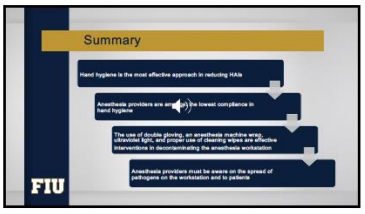


9

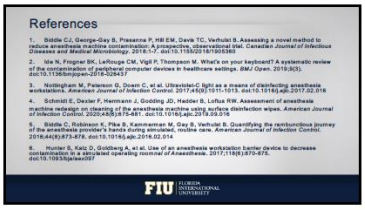


10

11



12



13

References

1. Centers for Disease Control and Prevention. Healthcare-associated infections data. https://www.cdc.gov/hai/data/index.html. Published October 5, 2018. Accessed September 11, 2021.
2. Biddle CJ, George-Gay B, Prasanna P, Hill EM, Davis TC, Verhulst B. Assessing a novel method to reduce anesthesia machine contamination: A prospective, observational trial. *Canadian Journal of Infectious Diseases and Medical Microbiology*. 2018:1-7. doi:10.1155/2018/1905360
3. Lo Giudice D, Trimarchi G, La Fauci V, Squeri R, Calimeri S. Hospital infection control and behavior of operating room staff. *Central European Journal of Public Health*. 2019;27(4):292-295. doi:10.21101/cejph.a4932
4. Ide N, Frogner BK, LeRouge CM, Vigil P, Thompson M. What's on your keyboard? A systematic review of the contamination of peripheral computer devices in healthcare settings. *BMJ Open*. 2019;9(3). doi:10.1136/bmjopen-2018-026437
5. Biddle C, Robinson K, Pike B, Kammerman M, Gay B, Verhulst B. Quantifying the rambunctious journey of the anesthesia provider's hands during simulated, routine care. *American Journal of Infection Control*. 2016;44(8):873-878. doi:10.1016/j.ajic.2016.02.014
6. Fukada T, Iwakiri H, Ozaki M. Anaesthetists' role in computer keyboard contamination in an operating room. *Journal of Hospital Infection*. 2008;70(2):148-153. doi:10.1016/j.jhin.2008.05.023

7. Biddle C. Semmelweis revisited: Hand hygiene and nosocomial disease transmission in the anesthesia workstation. *American Association of Nurse Anesthesiology.* 2009;77(3):229-237.
8. Alfred M, Catchpole K, Huffer E, Taafe K, Fredendall L. A work systems analysis of sterile processing: Sterilization and case cart preparation. *Advances in Health Care Management*. 2019:173-196. doi:10.1108/s1474-823120190000018008
9. Yuan I, Feldman JM. HAIs: When in Doubt, Blame Anesthesia. Could They Be Right? *The Official Journal of the Anesthesia Patient Safety Foundation*. https://www.apsf.org/wp-content/uploads/newsletters/2016/June/pdf/APSF201606.pdf. Published June 2016. Accessed September 12, 2021.
10. Nottingham M, Peterson G, Doern C, et al. Ultraviolet-C light as a means of disinfecting anesthesia workstations. *American Journal of Infection Control*. 2017;45(9):1011-1013. doi:10.1016/j.ajic.2017.02.016
11. Schmidt E, Dexter F, Herrmann J, Godding JD, Hadder B, Loftus RW. Assessment of anesthesia machine redesign on cleaning of the anesthesia machine using surface disinfection wipes. *American Journal of Infection Control*. 2020;48(6):675-681. doi:10.1016/j.ajic.2019.09.016
12. Hunter S, Katz D, Goldberg A, et al. Use of an anesthesia workstation barrier device to decrease contamination in a simulated operating room. *British Journal of Anaesthesia*. 2017;118(6):870-875. doi:10.1093/bja/aex097
13. Cost savings to hospitals - Tru-D SmartUVC. Tru-D. https://tru-d.com/cost-savings-to-hospitals/. Published June 4, 2019. Accessed October 3, 2021.

14. Loftus RW, Brown JR, Patel HM, et al. Transmission dynamics of gram-negative bacterial pathogens in the anesthesia work area. *Anesthesia & Analgesia*. 2015;120(4):819-826. doi:10.1213/ane.0000000000000626

15. Wong T, Woznow T, Petrie M, et al. Postdischarge decontamination of MRSA, VRE, and clostridium difficile isolation rooms using two commercially available automated ultraviolet-C–emitting devices. *American Journal of Infection Control*. 2016;44(4):416-420. doi:10.1016/j.ajic.2015.10.016

16. Loftus RW, Brown JR, Koff MD, et al. Multiple reservoirs contribute to intraoperative bacterial transmission. *Anesthesia & Analgesia*. 2012;114(6):1236-1248. doi:10.1213/ane.0b013e31824970a2

17. Anderson DJ, Chen LF, Weber DJ, et al. Enhanced terminal room disinfection and acquisition and infection caused by multidrug-resistant organisms and Clostridium difficile (the benefits of enhanced terminal room disinfection study): A cluster-randomized, multicentre, crossover study. *The Lancet*. 2017;389(10071):805-814. doi:10.1016/s0140-6736(16)31588-4

18. Moran KJ, Burson R, Conrad D. *The Doctor of Nursing Practice Scholarly Project*. Burlington, MA: Jones & Bartlett Learning; 2017.

19. Hospital-acquired conditions (present on admission indicator). CMS. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond. Accessed November 1, 2021.

20. United States Department of Labor. Hazardous Waste- Decontamination. https://www.osha.gov/hazardous-waste/decontamination. Accessed November 4, 2021.

21. National Cancer Institute. Dictionary of Cancer terms. https://www.cancer.gov/publications/dictionaries/cancer-terms/def/perioperative. Accessed November 4, 2021.
22. Merriam-Webster. Cross-contamination. https://www.merriam-webster.com/dictionary/cross%20contamination. Accessed November 4, 2021.
23. Tang LY, Wang J. Anesthesia and Covid-19: What We Should Know and What We Should Do. *Seminars in Cardiothoracic and Vascular Anesthesia*. 2020;24(2):127-137. doi:10.1177/1089253220921590