Marian University

Leighton School of Nursing

Doctor of Nursing Practice Final Project Report

Reducing Anesthesia Workstation Contamination

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Abstract

In the intraoperative setting, the intersection of hand hygiene practices and contamination of the anesthesia workstation presents a critical juncture for reducing hospital acquired infections that ultimately lead to increased patient morbidity and mortality. Microbiological contamination of the anesthesia workstation, most notably during routine tasks such as induction and airway management, has been directly linked to an increase in patient morbidity and mortality. The absence of standardized protocols to minimize contamination of the anesthesia workstation signals a crucial opportunity to improve the anesthetic workflow. This Doctor of Nursing project focused on educating student registered nurse anesthetists about intraoperative hand hygiene and ways to counter the contamination of their workstation, such as double gloving during induction and airway management. A pre-test survey was created to assess baseline knowledge of the topic and current hand hygiene practice during airway management. An evidence-based PowerPoint presentation was provided as an educational intervention, followed by a post-test survey to assess retention of knowledge and willingness to apply suggested methods to reduce contamination. The results showed that there was a significant improvement in the students' awareness, confidence, and willingness to apply the recommendations to reduce contamination of the anesthesia workstation. This project underscores the importance of targeted educational interventions in elevating healthcare quality through an improved anesthetic workflow that includes better hand hygiene and workstation cleanliness.

Introduction

Patient safety lies at the crux of an effective, well-rounded plan for healthcare delivery. This is especially notable in the intraoperative environment, where great attention to patient safety in the form of time-out protocols and constant double checks is exercised during all procedures, regardless of how benign the case may seem. The desire to prevent the transmission of hospital acquired infections (HAI) plays a major role in why these stringent protocols exist (Lo Giudice et al., 2019). For this reason, strict cleanliness and sterility is enforced. However, the operating room (OR) is a multidisciplinary environment that employs staff hailing from various backgrounds and training, making the maintenance of cleanliness a difficult issue to tackle if strict guidelines are not in place. Failure to comply with measures that prevent HAIs therefore place the patient at risk for increased morbidity and mortality (Lo Giudice et al., 2019). While numerous efforts are made to ensure a clean intraoperative working environment, universal anesthesia-specific infection prevention and control policies do not exist. As a result, it has been noted that the anesthesia workstation is culpable in increasing the risk of HAIs and patient mortality (Munoz-Price et al., 2019). Improper hand hygiene and infrequent disinfection of frequently used anesthetic equipment are common factors that promote the transmission of HAIs (Porteous et al., 2018).

The anesthesia workstation consists of multiple equipment that aid in the delivery of oxygen, anesthetic gases and medications, and ventilatory support. Some examples of components that comprise the anesthesia workstation include stopcocks and syringes, equipment for airway instrumentation such as laryngoscope blades and laryngeal masks, and documentation platforms such as touchscreens and keyboards (Munoz-Price et al., 2019). Due to the constant vigilance that anesthesia providers maintain when monitoring their patients, quick interventions

are often necessary and may be performed at the expense of contaminating the anesthesia workstation. In addition to the lack of an anesthesia-specific universal protocol to help guide expected practices and behaviors for cleanliness, the absence of routine audits that assess these practices and behaviors perpetuate the problem at hand. Providing anesthesia staff with specific recommendations for practices and behaviors that revolve around hand hygiene and environmental disinfection can reduce hospital acquired infections and improving patient safety. Just as importantly, education regarding this topic and reinforcement of proper hand hygiene or techniques to prevent contamination of the anesthesia workstation should be instituted and heavily reinforced in student registered nurse anesthetists (SRNAs) during their training. By adopting these positive behaviors as they develop their anesthetic routine and flow, students can curb maladaptive behaviors that would lead to improper hand hygiene and contamination of the workstation (Jaffe & Moriber, 2019).

Background

The increased risk of patient morbidity and mortality that accompanies hospital acquired infections is reason enough to mitigate precipitating factors, behaviors, and practices that heightens that risk. Furthermore, the proliferation of antibiotic-resistant pathogens has garnered much attention to the development of practical interventions that combat their growth (Porteous et al., 2018). Countless research and evidence-based practice have consistently proven the importance of basic hand hygiene in preventing pathogen transmission. Despite the abundant literature that supports this, compliance with effective hand hygiene remains poor amongst anesthesia providers (Porteous et al., 2018). The possibility of inadequate cleaning practices within the OR further compounds this issue by promoting the existence of multiple bacterial reservoirs (Porteous et al., 2018). In a study done on 19 anesthesia providers, it was noted that

out of 1000 times that they contacted their work environment, only 13 hand hygiene events were witnessed (Porteous et al., 2018). Another study found that adherence to the World Health Organization's recommendations for "5 Moments for Hand Hygiene" was approximately three percent (Porteous et al., 2018). These data are significant in highlighting the behaviors of anesthesia providers that contribute to the development of hospital acquired infections (Loftus et al., 2015b). Moreover, a direct pathway of intraoperative pathogen transmission occurs within the anesthesia workstation. This pathway links the anesthesia provider's hands to the syringe, the patient's intravenous line, and finally, the patient's bloodstream, further solidifying the risk of a hospital acquired infection (Porteous et al., 2018). Failing to consistently use gloves during airway instrumentation as well as skipping hand hygiene after removing gloves have been observed as problematic practices that exacerbate this possibility since they lead to contamination of equipment with secretions (Munoz-Price et al., 2019).

Due to the presence of several factors that contribute to contamination of the anesthesia workstation, it can be challenging to encourage anesthesia providers to adopt behaviors that mitigate bacterial spread especially during stressful situations such as intubation and emergence (Porteous et al., 2018). Many providers feel that the pressure of completing tasks within an expected timeframe poses the greatest barrier in abiding by infection prevention measures. Identifying the most frequent offenders of infection prevention within the anesthesia workstation, such as ineffective hand hygiene and infrequent disinfection of equipment, allows institutions to implement specific protocols to combat the issue. For instance, used medications syringes and the top of the anesthesia cart have been shown to be major mechanisms for pathogen transmission (Porteous et al., 2018). Based on this, medication preparation within the anesthesia workstation and any subsequent actions can be examined and tailored to include effective hand

hygiene and disinfection in between delivering steps of anesthetic care. Stethoscopes and laryngoscope handles, in addition to other reusable equipment, have also been cited as frequently contaminated equipment and are responsible for spreading infection if they have not been properly cleaned (Porteous et al., 2018). The implementation of a “contaminated” space and a “clean” space has been demonstrated to reduce microbiological contamination of the anesthesia workstation without negatively affecting workflow, which makes this an attractive consideration for providers (Porteous et al., 2018). By driving attention to this data, a heightened awareness can be exercised when developing cleanliness protocols that involve the anesthesia workstation.

A reduction in cross-contamination of the anesthesia workstation after performing tasks can be achieved through several ways. Bringing awareness to prevalence and ways of contaminating the anesthesia workstation through common tasks is essential to furthering this discussion. The consequences of contaminating the workstation should then be elucidated, since doing so will bring gravity to the matter. Education centered on evidence-based practice should be provided to anesthesia staff that details the benefits of implementing recommended guidelines to improve patient safety. For instance, one study showed that the use of double gloves compared to single gloves during induction has been proven to reduce cross-contamination (Jaffe & Moriber, 2019). The chances of being a vector for pathogen transmission are significantly reduced when the contaminated gloves are immediately disposed of after securing the airway. Providing data that substantiate new practices as illustrated with this double gloving technique provides more pause for thought and challenges anesthesia providers to reconsider their role in preventing infection (Loftus et al., 2015b). It is also important to note that practices amongst anesthesia providers may vary. In the same double gloving study, it was found that SRNAs were more likely to cross-contaminate the anesthesia workstation (Jaffe & Moriber, 2019). This was

attributed to inexperience and thus, a lack of a smoothly planned induction sequence compared to seasoned certified registered nurse anesthetists. The study also acknowledges that differences in the order and technique that anesthetic induction is done also exist amongst experienced providers. This further lends credence to the fact that the practice of anesthesia carries significant variability amongst providers and that standardizing infection control practices may prove to be a challenge. Based on this, it would behoove the anesthesia community to raise awareness regarding this topic and to reinforce techniques that guard against contamination while students are being trained. By addressing this issue with SRNAs during their training, the chance that they will develop unfavorable behaviors is lessened (Jaffe & Moriber, 2019).

Current standards dictate that ventilation of the patient immediately after airway instrumentation should be prioritized above all else (American Association of Nurse Anesthesiology [AANA], 2015). However, the AANA also recommends the practice of double gloving and the performance of hand hygiene during stable situations to mitigate bacterial transmission. The inclusion of specific recommendations, such as double gloving to prevent the spread of infection, amplifies the fact that anesthesia providers play a significant role in helping to curb transmission by reducing anesthesia workstation contamination.

Problem Statement

The intraoperative environment exposes the surgical patient to an increased risk of morbidity and mortality through the possibility of transmitting hospital acquired infections. Literature has shown that these infections are preventable and refining current practices can mitigate the risk of bacterial spread. Inadequate cleaning practices in the OR may lead to the proliferation of reservoirs that house harmful pathogens. Another consideration recognizes the fact that anesthesia providers may play a role in worsening this risk of pathogen transmission

through routines that are deficient in hand hygiene and equipment disinfection. This leads to microbiological contamination of the anesthesia workstation, most notably after securing a patient's airway due to presence of secretions. Studies have shown poor compliance in hand hygiene and disinfection practices amongst anesthesia providers. Additionally, differences in levels of training contribute to practices that increase the risk of workstation contamination. The purpose of this project would be to educate SRNAs on the prevalence and consequences of anesthesia workstation contamination, identify common practices that aggravate contamination, and provide solutions to reduce contamination, namely double gloving. This led to the following PICO:

Among SRNAs, what is the effect of raising awareness on anesthesia workstation contamination and methods to reduce this occurrence?

Needs Assessment and Gap Analysis

The lack of a universal infection prevention protocol in anesthesia leads to variability in practice that impacts patient safety. A negative consequence of this variability in practice is the development of a HAI. A contributing factor to this may be pathogen transmission from a contaminated anesthesia workstation. Anesthesia providers may not be aware of how impactful their practices around a contaminated anesthesia workstation are in terms of contributing to a HAI. The AANA does reinforce the adoption of habits that emphasize cleanliness, such as double gloving and frequent hand hygiene; but ultimately, the greatest emphasis is placed on securing a patent airway during induction. This may encourage providers to relinquish the act of infection prevention for the sake of obtaining a secure airway.

Efforts have been made to educate anesthesia providers on their role in infection prevention. Studies that show demonstrable improvements in prevention of pathogen transmission should be utilized as educational material in addressing this knowledge gap. Since current practice foregoes a standardized approach in reducing anesthesia workstation contamination, this project aims to improve the literacy of SRNAs regarding practices that instigate anesthesia workstation contamination and methods that can be done to reduce that incidence, namely through double gloving during intubation, and ultimately, prevent escalation of a patient's risk of morbidity and mortality.

Review of the Literature

The increased patient mortality that arises from HAIs deserves special attention in the realm of anesthesia since anesthesia providers have been implicated as sources of intraoperative pathogen transmission (Loftus et al., 2015a). The overarching theme found in the literature review highlighted the need for improved compliance with proper hand hygiene amongst most anesthesia providers (Lo Giudice et al., 2019; Loftus et al., 2015a; Munoz-Price et al., 2018; Paul et al., 2019). This practice problem is compounded when poor hand hygiene contributes to contamination of the anesthesia workstation (Munoz-Price et al., 2019). Furthermore, there is a lack of universal infection prevention practices and audits in the OR. The traits and behaviors of individual anesthesia providers when administering care are unique, which makes the implementation of an infection prevention bundle beneficial in reducing behaviors that lead to anesthesia workstation contamination (Porteous et al., 2018). Continued research pointed to the presence of frequently contaminated sites on the anesthesia workstation and their contribution to pathogen transmission (Loftus et al., 2015a). Finally, while there is a dearth of studies that explicitly link the efficacy of double gloving during induction to reduce anesthesia workstation

contamination, the evidence that does exist in support of this practice is significant. However, it is important to note that double gloving is not a substitute for proper sterilization and disinfection of equipment, and that both measures should be used to prevent contamination of the anesthesia workstation.

Lo Giudice et al. (2019) provided an observational descriptive study citing the low adherence that OR staff showed in regard to abiding by international guidelines for the prevention of HAIs, including hand and workplace hygiene. This is especially significant when evidence has shown that the hands of anesthesia providers are common sources of harmful pathogens, such as enterococci (Loftus et al., 2015a). A prospective randomized clinical trial led by Loftus et al. (2020) showed that by proving anesthesia practitioners with direct recommendations to reduce bacterial transmission, a decrease in perioperative *S. aureus* transmission was observed. This lends credence to the establishment of an infection prevention bundle in the OR setting to help reduce contamination of the anesthesia workstation (Porteous et al., 2018). The anesthesia workstation serves as a major vector for HAIs and therefore increases patient mortality (Plemmons et al., 2019). Sites of frequent contamination on the workstation include the circuit, APL valve, and manual ventilation bag (Hunter et al., 2017). Contamination of these sites often results from the lack of proper hand hygiene after certain phases of the anesthesia workflow, most notably induction or airway management (Munoz-Price et al., 2019).

Several studies were developed to address the origins of anesthesia workstation contamination and measures that can be taken to reduce this occurrence. Biddle et al. (2016) highlighted the use of double gloves during airway management as a significant contributor in decreasing contamination of airway equipment, the breathing system, intravenous access ports, and the roll of tape used to secure the endotracheal tube ($p<0.001$). Birnbach et al. (2015a)

recommends double gloving during laryngoscopy and removing the outer set immediately after intubation to reduce contamination of the intraoperative environment ($p<0.001$). While the aforementioned studies involved simulated cases, a non-simulated study done by Jaffe & Moriber (2019) emphasized that level of training could be a factor in how efficient a double gloving method is in reducing contamination. It was posited that due to the lack of clinical experience that SRNAs possessed compared to experienced CRNAs, their induction sequences may not be as well-choreographed and timed, leading to higher chances of errors and contamination. This further strengthens the argument for early education and intervention in cultivating behaviors that prevent workstation contamination. Another study done by Birnbach et al. (2015b) offered the solution of sheathing the laryngoscope directly with the outer glove after endotracheal intubation to further reduce intraoperative environmental contamination ($p<0.001$).

See Appendix A for the literature review matrix.

Literature Search Methodology

This literature review was performed to establish the significance between ineffective hand hygiene and the resultant contamination of the anesthesia workstation which, in turn, leads to an increased incidence of HAIs and patient morbidity and mortality. This search was conducted between September 2022 through December 2022. The main database used to support this search was *OVID-Medline.* The keywords used to conduct the search were *anesthesia, equipment, contamination, cross infection, hand hygiene, induction,* and *intubation.* Truncation of the terms *anesthesia*, *double glove,* and *intubation* allowed for more variation in the search while continuing to respect the main concept being studied. Various combinations of the aforementioned terms along with the BOOLEAN operator AND yielded the most definitive results. Exclusion criteria to eliminate confounding variables include non-English articles and

articles published before 2012. Inclusion criteria include full-text English articles published no earlier than 2012. After applying these criteria to the searches, 136 total articles were procured. Of those articles found, 19 articles from the database search were deemed to be most pertinent to the project. An additional 4 articles were hand-picked from various sources to support this research.

Theoretical or Conceptual Framework

The Knowledge-to-Action framework (KTA) will serve as the foundation for this project. The KTA model was developed in 2006 by Dr. Ian Graham and his colleagues at the University of Ottawa in an effort to streamline the process of knowledge acquisition and its eventual translation into practice (Graham et al., 2006). The two main concepts that ground the framework are knowledge creation and action. The knowledge creation funnel entails knowledge inquiry, knowledge synthesis, and knowledge tools or products. The action cycle has seven phases that guide the knowledge application: 1: identifying a problem that necessitates change; 2: adapting knowledge to local context; 3: assessing barriers and facilitators to knowledge use; 4: selecting and tailoring interventions; 5: monitoring knowledge use; 6: evaluating outcomes; and 7: sustaining the change or use of knowledge (See Appendix B). In relation to this project, the framework will be carried out as follows:

Knowledge Creation

The step of inquiry presents the overarching issue of the HAIs and causative factors. Knowledge synthesis provides evidence that details specific causative factors, such as improper hand hygiene leading to anesthesia workstation contamination and eventual pathogen

transmission to the patient. The knowledge tools used to obtain this information are clinical practice guidelines and peer-reviewed journals.

Action

The problem identified is the lack of proper hand hygiene that leads to anesthesia workstation contamination. The use of gloves aids in reducing contamination. Encouraging anesthesia providers to double glove during intubation displays knowledge adaptation on a local level. Common barriers to implementation should be addressed and then followed with recommended interventions. Retention of knowledge from the educational material will be monitored by a post-test survey. Ongoing knowledge use will have to be carried out through self-accountability or by the anesthesia providers' respective institutions if applicable.

Project Aims and Objectives

The purpose of this project is to increase awareness regarding ways through which the anesthesia workstation can be contaminated and to introduce the concept of double gloving as a means to reduce the incidence of contamination. The contamination of the anesthesia workstation with pathogens that lead to HAIs increases the chances of patient morbidity and mortality (Loftus et al., 2015b). While the vehicle through which contamination occurs varies depending on the task that the anesthesia provider is performing, one major culprit behind most forms of contamination is improper hand hygiene (Porteous et al., 2018). The aim of this project lies in delivering educational material that increases awareness of ways through which anesthesia workstation contamination occurs and how double gloving can reduce those incidences. The objectives of this project will involve creating educational material to disseminate the information stated above. SRNAs will be surveyed on their familiarity with anesthesia

workstation contamination and their current practices that influence this occurrence. After providing educational material, the SRNAs will be surveyed to assess their understanding of the material provided and their willingness to adopt a change in their practice (i.e., double glove for intubation). By encouraging double gloving as a cornerstone in reducing contamination, better hand hygiene practices can be adopted by anesthesia providers, leading to reduced incidences of anesthesia workstation contamination.

Project Design

This DNP project is utilizing an educational and quality improvement/program evaluation design to spread awareness concerning how frequently the anesthesia workstation is contaminated through improper hand hygiene and measures that can be taken to combat this. Rather than using direct observation to assess anesthesia providers' hand hygiene practices in the operating room, a pre- and post-test self-assessment survey will be provided to consenting SRNAs through *Qualtrics* to obtain quantitative data to support this project. The pre-test survey will establish the participants' baseline knowledge and attitudes of their hand hygiene practices in the perioperative setting, particularly during intraoperative procedures such as intubation, and the resulting contamination of the anesthesia workstation, particularly areas that are frequently touched. Subsequently, an educational PowerPoint will be provided to disseminate information regarding practices that lead to anesthesia workstation contamination and measures that can be taken to improve this, such as double gloving. After viewing the PowerPoint material, a post-test survey will be conducted to assess whether the educational material was effective in raising awareness regarding anesthesia workstation contamination and encouraging the adoption of certain practices, such as double gloving, as a means of reducing contamination.

Project Site and Population

The study will be conducted online through a *Qualtrics* survey and will focus on SRNAs at a small, private Catholic university in the Midwest who are training in inpatient and outpatient settings in Indiana, Ohio, Illinois, and Tennessee. The SRNAs surveyed have an expected graduation year of 2024, 2025, and 2026. Those in the 2024 cohort will have almost completed their clinical experience while those in the subsequent cohorts will have had varying degrees of exposure to clinical experience. All cohorts will have undergone training and practice through clinical simulation scenarios as part of their curriculum prior to entering the actual clinical arena. During training, SRNAs under the supervision of a CRNA or MDA will be involved in airway management and as such, will have opportunities to double-glove when doing so. Resources needed to complete the project include access to *Qualtrics* and valid email addresses from the participants. Key stakeholders in this project include the consenting participants and the project chairpersons.

Measurement Instruments

To measure the outcomes of this DNP project, an online self-assessment survey generated through *Qualtrics* will be used. The survey will consist of 10 quantitative questions to test knowledge and 2 questions that assess current and future hand hygiene practice, as well as a total of 13 questions taken from National League of Nursing's (NLN) Student Satisfaction and Self-Confidence in Learning to gauge the survey taker's overall impression of the learning process (see Appendices C and D). Participants will be provided with an email that contains the following links: a pre-test survey on *Qualtrics* to assess their baseline knowledge regarding anesthesia workstation contamination; an educational 15-minute PowerPoint presentation which will explicate the importance of combating contamination of the workstation and methods to do so, namely double gloving; and a post-test survey on *Qualtrics* for comparative data collection.

The students will be asked to use the same student identification number on both surveys. The data will be collected over the course of two weeks. Anonymity will be maintained by eliminating any uniquely identifiable information. The common themes encountered in the literature review will serve as the basis for developing the questions used in the surveys.

Data Collection and Procedure

The invitation to participate in data collection is voluntary and anonymous and will be done through e-mail. The e-mail will contain an anonymous link for the *Qualtrics* survey. These steps will ensure that no personally identifiable data is collected and that the reputation of participants will be protected. The e-mail addresses will be obtained with the help of the project site contact person. Participants will be given two weeks complete the surveys.

Based on the samples expected to be collected, statistical data analysis for the first 12 questions will be conducted through the use of a parametric paired *t*-test. The subsequent responses from the NLN survey will be analyzed using a non-parametric approach with the Wilcoxon signed rank test.

Project Evaluation Plan

The benefit of using *Qualtrics* is the anonymity it provides and the feasibility of exporting data directly to SPSS, CSV, PDF, and Microsoft Word, PowerPoint, and Excel. Statistical data analysis will be done by comparing pre- and post-test answers and discerning whether providers intend to implement a practice change to reduce their chances of contaminating the anesthesia workstation. Using an Excel spreadsheet allows for easier comparison of these answers. The use of inferential statistical analysis, such as performing a paired *t*-test, helps to determine whether the relationship amongst the variables is statistically

significant. If the p-value is less than the significance level, then a determination can be made that the educational material was effective in disseminating the intended information.

Ethical Considerations

Approval from the Marian University Internal Review Board was obtained prior to moving forward with this project (see Appendix E). By using the link provided in the email, participants acknowledged their informed consent and voluntary involvement in the project. There was no patient data collection, making the Health Insurance Portability and Accountability Act of 1996 (HIPPA) inapplicable. There was no personally identifiably data collected from the participants. There were no appreciable ethical concerns or risks associated with this DNP project.

SWOT Analysis

Key stakeholders in this project include SRNAs, practicing anesthesia providers, patients, and facilities that favor adoption of double gloving when intubating as part of their infection prevention policy. The prevention of HAIs is central to numerous discussions and research in the medical community. The strengths of this project lie in bringing awareness to the role that a contaminated anesthesia workstation plays in contributing to HAIs and recommendations to decrease that incidence. Gloves are readily available in the healthcare setting, making the intervention of double gloving easily implementable. Some barriers to this project include differences in habits across anesthesia providers. Differences in experience levels can inform different practices and priorities, leading some providers to possibly relinquish infection prevention through double gloving in favor of securing a patent airway and confirming ventilation with contaminated gloves. There is also a lack of abundant research that relates

specifically to double gloving during intubation, which may cause providers to hesitate in adopting this practice. Opportunities exist to improve current practice guidelines related to hand hygiene within the anesthesia workstation. Facility protocols and didactic curricula can be adapted to include this practice and further reduce the incidence of HAIs. Threats to this project include a lack of interest amongst SRNAs in changing habits and practices that they have methodically developed to ascertain patient safety when securing an airway. Understandably, the priority of securing an airway in an emergent situation may override the infection prevention that double gloving provides. However, it benefits the anesthesia provider to consider adopting and mastering the double gloving technique to optimize patient safety and wellness. See appendix F for a table outline of the SWOT analysis conducted for this project.

GANTT Chart

See Appendix G for the GANTT chart.

Data Analysis and Results

The three cohorts invited to participate in this study were composed of a diverse group of 99 SRNAs. Of those 99 SRNAs, 16 valid responses were obtained, resulting in a survey completion rate of roughly 16%. All of the participants were aware of how HAIs continue to be a major public health concern that greatly increases patient morbidity, mortality, overall healthcare costs, and potential liability. In the pre-test survey, 88% of respondents were aware that bacterial contamination of the anesthesia workstation can occur as early as 4 minutes of starting a case, but they assumed that out of an average 149 opportunities to perform hand hygiene, anesthesia providers had a 10% compliance rate when in fact, it was closer to 3%. Additionally, 88% of respondents believed that most of the contamination occurs during induction and intubation and

that every surface of the anesthesia workstation becomes contaminated during the process. Despite being one of the most frequently contaminated items on the anesthesia workstation, the circuit was not chosen by any respondents as a viable option. Prior to the educational intervention, 38% of participants believed that the encouragement of frequent hand hygiene in isolation should be enough to reduce contamination during airway management. In the post-test survey, 100% of participants believed that double gloving and sheathing the laryngoscope immediately after intubation was the best way to mitigate contamination of the anesthesia workstation. There was an improvement in the understanding of the use of low-level chemical disinfection after each patient as well. Of note, there was a marked difference in the responses for questions 4 and 8 ($p < 0.05$) which demonstrates that hand hygiene compliance is often overestimated in anesthesia providers. Prior to the PowerPoint presentation, 88% of respondents did not include double gloving in their practice compared to 100% of respondents who claimed to be more willing to adopt this technique after the presentation.

Although a limitation of this project includes subjective data from a small sample size in a single institution ($n = 16$), the post-test survey showed a notable enhancement in the students' self-perception of competence regarding anesthesia workstation contamination ($p < 0.05$). The participants reported a greater ability to leverage the presentation as a tool to augment their clinical experiences. Future research, ideally involving larger cohorts across multiple institutions and objective measures such as direct observation and simulation-based assessments, can be performed to validate and build upon these preliminary insights.

Conclusion

This DNP project underscores the significance of educating SRNAs regarding the role that the anesthesia workstation plays in contributing to HAIs and proven methods the mitigate

that risk. Despite the challenge of a modest response rate, the findings illuminate a clear pathway towards improving patient safety and clinical outcomes in the perioperative settings. Before the intervention, there was a notable gap between the perceived and actual practices of hand hygiene and equipment handling among anesthesia providers. The project demonstrated that a targeted educational program could significantly alter SRNAs' future practices, particularly regarding double gloving and proper handling of the laryngoscope during airway management to offset contamination risks. The unanimous endorsement of double gloving and improved knowledge of equipment disinfection highlights the effectiveness of educational strategies in fostering behavioral change.

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Appendix A

Citation	Research Design & Level of Evidence	Population/Sample size n=x	Major Variables	Instruments/Data Collection	Results
(Biddle et al., 2016)	Randomized control trial, Level I	Convenience sample of experienced anesthesia providers; n=20 (control group [n=10], experimental group [n=10])	Experience in anesthetic induction, single vs. double gloving, contamination of various anesthetic equipment, effectiveness of workspace disinfection between cases; phases of induction sequence; prolific contamination sites	High fidelity simulation of anesthetic induction with SimMan 3G, surrogate biologic contamination (DAZO), UV light, and photographs of SimMan and workstation where dye was displaced; 2-group *t* test to test hypothesis	Group 1 (single pair of gloves) contaminated more of the workstation compared to group 2 (double pair of gloves, especially with airway management ($p<0.001$). However, there were similar rates of contamination in both groups for airway equipment, breathing system, intravenous access ports, and the roll of tape used to secure the endotracheal tube.
(Birnbach et al., 2015a)	Double-blinded randomized control trial; Level I	Anesthesiology residents (PGY 2-4); at the University of Miami Miller School of Medicine n=45	Single vs. double gloving and its effects on contaminating OR equipment; OR sites of frequent contamination	22 total individual and group simulation sessions of anesthetic induction and tracheal intubation; 11 sessions required single gloves and 11 sessions required double gloves; DAZO used as surrogate biological pathogen/blood, UV light; Poisson regression to analyze total number of contaminated sites; χ^2 or Fisher exact test to analyze proportion of objects positive for fluorescent markers	Double gloving during laryngoscopy and intubation and removing the outer set immediately after intubation drastically reduces contamination of the intraoperative environment ($p< 0.001$).
(Birnbach et al., 2015b)	Blinded randomized control trial; Level I	Anesthesiology residents (PGY 2-4) at the University of Miami-Jackson	Single vs. double gloving vs. double gloves with sheathing of	45 total identical simulation sessions involving anesthetic induction and endotracheal intubation lasting 6 minutes	All 3 conditions used for simulation were statistically different from one another ($p<0.001$); sheathing the laryngoscope immediately after endotracheal intubation

		Memorial Hospital Center for Patient Safety between December 2013 and December 2014; n=45	laryngoscopy handle/blade in glove after endotracheal intubation and their effects on contamination of the work area and IV hub; laryngoscope handle/blade	(15 sessions with control group using single gloves; 15 sessions with double gloves and outer pair removed after intubation; 15 sessions with double gloves and sheathing of laryngoscope in one of outer gloves after intubation); DAZO and mannequin; Poisson regression to analyze results	reduces contamination of the IV hub, patient, and intraoperative environment ($p<0.001$)
(Hunter et al., 2017)	Prospective randomized control trial; Level I	Attending anesthetists (n=19) and resident anesthetists (n=23) at the Mount Sinai Department of Anesthesiology Simulation Center	Physical barrier device covering the anesthesia workstation during induction and intubation and its effects on reducing contamination of 14 target sites; level of training	Simulated OR scenario requiring induction and a barrier device on the anesthesia workstation; barrier device was removed with the barrier group after induction and then examined for the presence of Glo-Germ fluorescent dye	There was a significant reduction in the number of sites contaminated in the barrier group compared to the control group ($p<0.001$); residents demonstrated a lower site contamination rate compared to attending anesthetists in the control group; in the barrier group, overall contamination rates were similar between residents and attendings; sites with the highest rate of contamination were the circuit, APL valve, and manual ventilation bag;
(Jaffe & Moriber, 2019)	Prospective quasi-experimental study, Level III	SRNAs (2^{nd} and 3^{rd} year of training) and CRNAs at an inner-city level 2 trauma center; n=30	Single vs. double gloving and impact on cross-contamination of equipment; level of training	Evaluation of double gloving during induction in the experimental group in a non-simulated OR; evaluation was conducted thrice (pre-/post-education on double gloving and 1 month post-education); 5-question survey post-education to evaluate learning; UV blacklight used to observe for inoculation before and after induction;	Double gloving during induction decreases cross-contamination of the of anesthesia equipment by more than 50% ($p<0.01$).
(Lo Giudice et al., 2019)	Observational descriptive study, Level III	Operating room personnel at a University hospital in southern Italy; n=308	OR personnel profession and level of training; OR apparel; number of personnel in the	402 surgical procedures were randomly selected for observation wherein healthcare personnel involved in the operations were monitored for	OR staff displayed low adherence to international guidelines for prevention of healthcare associated infections, including hand hygiene and workplace hygiene (OR sanitation).

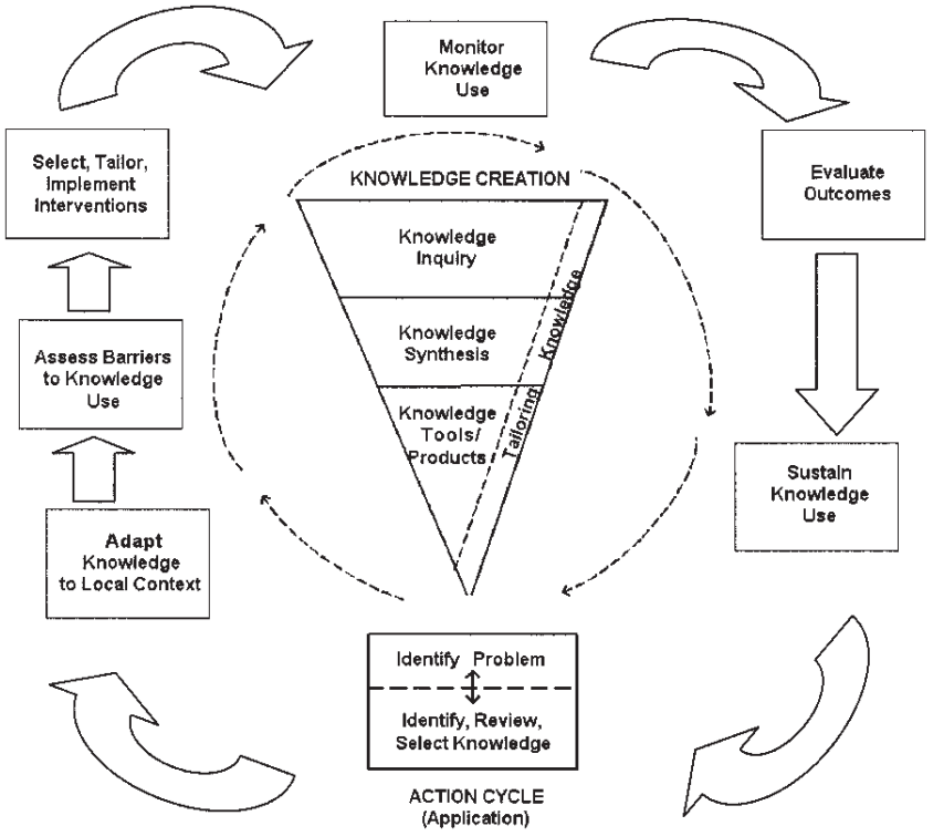
			OR; adherence to international guidelines for infection prevention; surgical procedures	compliance with international guidelines for infection prevention; trained healthcare workers performed the observation and data was collected using a special form and no prior notice was given to the OR team	
(Loftus et al., 2012)	Prospective randomized observational study, Level II	Operating room case pairs in a multicenter study, n=548	Stopcock contamination; anesthesia provider hands; environment to stopcock contamination	274 operating rooms were observed for stopcock transmission events; reservoir bacterial cultures were collected and compared to stopcock set isolates to determine source of contamination	All 3 reservoirs (64% environment, 12% patient, 21% provider) contributed to increased stopcock transmission, which is associated with an increased risk for patient mortality. Compared to the providers' hands, the environment was a more likely source of stopcock contamination (p=0.029).
(Loftus et al., 2015a)	Systematic review of previously conducted RCT, Level I	Environmental bacterial culture sites, n=2170; health care provider hand cultures, n=2640; patient skin cultures in 274 case-pairs representing 548 ORs across 3 major academic medical centers, n=1087	Anesthesia reservoir isolates; contamination of frequently touched surfaces by anesthesia providers	From a previous RCT, enteroccocus isolates were previously obtained from bacterial reservoirs that anesthesia providers frequently encountered (patient nasopharynx and axilla, anesthesia provider hands, and the adjustable pressure-limiting valve and agent dial of the anesthesia machine) by gross morphology and simple rapid tests;	Anesthesia provider hand contamination is a common source of enterococcus transmission in the anesthesia work area.
(Loftus et al., 2015b)	Systematic review of randomized clinical trials, Level III	n/a	n/a	A systematic review of multiple clinical trials was conducted to confirm the hypothesis that the anesthesia workstation serves as a direct source of HAIs and a multimodal approach should be used to combat contamination.	HAIs have been directly associated with bacterial transmission from anesthesia workstations; considerations should be made to attenuate bacterial transmission during the provision of anesthesia, including intraoperative hand hygiene and environmental decontamination.

(Loftus et al., 2020)	Prospective randomized clinical trial, Level I	Adult patients scheduled to undergo orthopedic total joint, orthopedic spine, oncologic gynecological, thoracic, general, colorectal, open vascular, plastic, and open urological surgery requiring general and/or regional anesthesia at a major academic medical center, n=236	Serially collected bacterial cultures obtained from each patient; baseline and post-case anesthesia environment; hands of anesthesia provider; intravascular catheter samples	Provision of CDC recommendations regarding basic preventive measures to reduce bacterial transmission on 236 patients; those patients were followed for 60 postoperative days to observe for evidence of SSI.	Improved perioperative basic preventive measures can be taken to decrease perioperative *S aureus* transmissions and SSIs (p=0.002).
(Munoz-Price et al., 2019)	Expert guidance, Level V	n/a	n/a	To develop this expert guidance, surveys were sent to providers who were members of the ASA, AANA, and AAAA regarding practices in the OR. PICO questions guided research.	Infection prevention/control policies related to anesthesia in the OR are not universal in the US; audits of infection prevention and control practices are not routine; anesthesia work areas are not thoroughly cleaned/disinfected between each patient and the anesthesia cart poses a risk for cross contamination; anesthesia providers showed <100% gloving for airway management and lack of hand hygiene after removing gloves as well as using cart drawers without proper hand hygiene. Multiple recommendations are made to address these issues, including the use of double gloves during airway management.
(Paul et al., 2019)	Pretest-posttest design/quasi-experimental study, Level III	Anesthesia providers in the main ORs of a university-affiliated community hospital in the Southeastern U.S.; n=60	Increased access to hand hygiene products; educational intervention; hand hygiene indications; phases of anesthesia; professional categories	Observation of anesthesia providers' hand hygiene compliance while administering various anesthetics; pretest-posttest design and educational intervention.	Preimplementation results revealed very low compliance with hand hygiene among anesthesia providers in the OR, especially during induction. Postimplementation phase revealed a marked increase in sustained compliance with hand hygiene (p<0.001).

(Plemmons et al., 2019)	Direct observation, Level III	Convenience sample of nurse anesthetists who work in the main OR of a 957-bed medical center in the Southeastern U.S.; n=35	Baseline hand hygiene practices; 3 modifiable practices; educational interventions; improvement in clean workspace behaviors postimplementation	Nurse anesthetists were observed for hand hygiene practices in 3 areas of anesthesia practice (hand hygiene after airway instrumentation, medication administration, and separation of clean and contaminated items in the workspace) before/3 weeks after/3 months after education using a Fisher exact test; self-assessment tool was provided to determine baseline practices.	Cross-contamination of the anesthesia workspace increases the risk of HAIs. The provision of education, visual reminders, and standardized infection control guidelines increase compliance with hand hygiene after airway instrumentation (p=0.29) and the practice of separating clean from contaminated items in the anesthesia workspace (p=0.0001).
(Porteous et al., 2018)	Nonrandomized simulation scenario crossover design study, Level II	Anesthesiology residents (PGY 3 and 4), attending anesthesiologists, and CRNAs from the Department of Anesthesiology at Virginia Mason; n=25	Infection prevention bundle (double gloving, isolating airway equipment to a single area, increased hand hygiene); 20 frequently contaminated anesthesia workstation sites; high-risk events for contamination, including induction and airway management	Simulations of cases at baseline without implementing the infection prevention bundle initially followed by simulations of cases that required implementation of the infection prevention bundle.	Implementing an infection prevention bundle reduced contamination by 27% (p=<0.001); clinician hands were a major source of intraoperative pathogen transmission in the anesthesia work area.

Appendix B

Knowledge-to-Action Framework



(Graham et al., 2006)

Appendix C

Qualtrics survey questions

1. True or False: Hospital acquired infections (HAIs) continue to be a major public health concern and greatly increases patient morbidity, mortality, overall healthcare costs, and potential liability.

- ○ True
- ○ False

2. Which pathogen, commonly found as part of our normal microbiota in our upper respiratory tract and skin, is commonly implicated in the development of HAIs?

- ○ Enterococcus
- ○ Staphylococcus Aureus
- ○ Klebsiella
- ○ Acinetobacter
- ○ Pseudomonas
- ○ Enterobacter

3. Please choose the best answer based on your assumption about the OR environment:

- ○ Bacterial contamination of the anesthesia workstation occurs after 30 minutes of starting a case
- ○ Anesthesia providers' hands are unlikely to carry harmful pathogens
- ○ The anesthesia workstation is a major vector for HAIs and can become contaminated within 4 minutes of starting a case
- ○ Bacterial transmission from the anesthesia workstation is a root cause of 1-day postoperative infections in approximately 30% of surgical patients

4. In a study of hand hygiene practices among anesthesia providers, an average of 149 opportunities to perform hand hygiene was found. What do you think the compliance rate was?

- ○ 10%
- ○ 50%
- ○ 3%
- ○ 90%

5. Contamination of the anesthesia workstation is primarily attributed to inadequate hand hygiene following which critical phase of the workflow?

- ○ Post-surgical closure and patient transport
- ○ Medication administration and induction
- ○ Post-operative recovery and equipment sterilization
- ○ Induction and intubation

6. In a study focused on contamination during induction and airway management, what do you presume would be the most significant finding regarding surface contamination, even for areas not directly used at that particular time?

- ○ Only some surfaces were found to be contaminated
- ○ Every surface examined was found to be contaminated
- ○ No contamination was observed on any surface
- ○ Contamination was limited to the laryngoscope handle and blade

7. Choose between 1 - 3 most frequently contaminated items on the anesthesia workstation:

- ☐ Circuit
- ☐ Roll of tape
- ☐ APL valve
- ☐ Face mask
- ☐ Manual ventilation bag
- ☐ Vaporizer

8. What are some proven methods to reduce contamination during airway management, thereby reducing contamination of the anesthesia workstation?

- ○ Double gloving and sheathing the laryngoscope immediately after intubation
- ○ Increasing the number of available laryngoscopes
- ○ Using single gloves for better tactile sensitivity
- ○ Encouraging frequent hand hygiene only

9. What key approach can help establish standardization in contamination reduction practices within the anesthesia workstation?

- ○ Frequent equipment replacement
- ○ Continuous hand hygiene training
- ○ Audits and objective monitoring
- ○ Increasing the number of personnel

10. What is the recommended approach to disinfection surfaces in anesthesia workstations to minimize the risk of pathogenic transmission?

- ○ High-level chemical disinfection after every patient
- ○ Use of non-EPA registered disinfectants
- ○ Performing daily high-level chemical disinfection after the last case of the day
- ○ Low-level chemical disinfection after each patient with EPA-registered disinfectants

11. Do you currently double glove in your practice during induction and airway management?

- ○ Yes
- ○ No

12. If you don't already use the double-gloving technique during induction and airway management, would you be more willing to do so after participating in this educational session?

- ○ Yes
- ○ No

Appendix D

National League of Nursing Student Satisfaction and Self-Confidence in Learning Survey

Student Satisfaction and Self-Confidence in Learning

Instructions: This questionnaire is a series of statements about your personal attitudes about the instruction you receive during your simulation activity. Each item represents a statement about your attitude toward your satisfaction with learning and self-confidence in obtaining the instruction you need. There are no right or wrong answers. You will probably agree with some of the statements and disagree with others. Please indicate your own personal feelings about each statement below by marking the numbers that best describe your attitude or beliefs. Please be truthful and describe your attitude as it really is, not what you would like for it to be. This is anonymous with the results being compiled as a group, not individually.

Mark:
1 = STRONGLY DISAGREE with the statement
2 = DISAGREE with the statement
3 = UNDECIDED - you neither agree or disagree with the statement
4 = AGREE with the statement
5 = STRONGLY AGREE with the statement

Satisfaction with Current Learning	**SD**	**D**	**UN**	**A**	**SA**
1. The teaching methods used in this simulation were helpful and effective.	○ 1	○ 2	○ 3	○ 4	○ 5
2. The simulation provided me with a variety of learning materials and activities to promote my learning the medical surgical curriculum.	○ 1	○ 2	○ 3	○ 4	○ 5
3. I enjoyed how my instructor taught the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
4. The teaching materials used in this simulation were motivating and helped me to learn.	○ 1	○ 2	○ 3	○ 4	○ 5
5. The way my instructor(s) taught the simulation was suitable to the way I learn.	○ 1	○ 2	○ 3	○ 4	○ 5
Self-confidence in Learning	**SD**	**D**	**UN**	**A**	**SA**
6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me.	○ 1	○ 2	○ 3	○ 4	○ 5
7. I am confident that this simulation covered critical content necessary for the mastery of medical surgical curriculum.	○ 1	○ 2	○ 3	○ 4	○ 5
8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting	○ 1	○ 2	○ 3	○ 4	○ 5
9. My instructors used helpful resources to teach the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
10. It is my responsibility as the student to learn what I need to know from this simulation activity.	○ 1	○ 2	○ 3	○ 4	○ 5
11. I know how to get help when I do not understand the concepts covered in the simulation.	○ 1	○ 2	○ 3	○ 4	○ 5
12. I know how to use simulation activities to learn critical aspects of these skills.	○ 1	○ 2	○ 3	○ 4	○ 5
13. It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time..	○ 1	○ 2	○ 3	○ 4	○ 5

 Revised December 22, 2004

Appendix E

Marian University IRB Approval Letter

MARIAN UNIVERSITY
Indianapolis ®

Institutional Review Board

DATE:	04-24-2023
TO:	Kristine Moncada & Dr. Lee Ranalli
FROM:	Institutional Review Board
RE:	S23.161
TITLE:	Reducing Anesthesia Workstation Contamination
SUBMISSION TYPE:	New Project
ACTION:	Determination of EXEMPT Status
DECISION DATE:	04-24-2023

The Institutional Review Board at Marian University has reviewed your protocol and has determined the procedures proposed are appropriate for exemption under the federal regulation. As such, there will be no further review of your protocol and you are cleared to proceed with your project. The protocol will remain on file with the Marian University IRB as a matter of record.

Although researchers for exempt studies are not required to complete online CITI training for research involving human subjects, the IRB **recommends** that they do so, particularly as a learning exercise in the case of student researchers. Information on CITI training can be found on the IRB's website: http://www.marian.edu/academics/institutional-review-board.

It is the responsibility of the PI (and, if applicable, the faculty supervisor) to inform the IRB if the procedures presented in this protocol are to be modified of if problems related to human research participants arise in connection with this project. Any procedural modifications must be evaluated by the IRB before being implemented, as some modifications may change the review status of this project. Please contact me if you are unsure whether your proposed modification requires review. Proposed modifications should be addressed in writing to the IRB. **Please reference the above IRB protocol number in any communication to the IRB regarding this project.**

Amanda C. Egan, Ph.D.
Chair, Marian University Institutional Review Board

Appendix F

SWOT Analysis Table

Strengths	Weaknesses
• Increased awareness of contaminated anesthesia workstations contributing to HAIs • Gloves are readily available, making double gloving an easily implementable intervention	• Differences in habits and experience levels across anesthesia providers could hinder consistent implementation • Lack of abundant research specifically related to double gloving uring intubation may cause hesitation in adopting this practice
Opportunities	**Threats**
• Improve current practice guidelines related to hand hygiene within the anesthesia workstation • Adapt facility protocols and didactic curricula to include the practice of double gloving to reduce the incidence of HAIs	• Lack of interest among SRNAs in changing habits and practices for securing an airway • The priority of securing an airway, especially in emergent situations, may override the infection prevention benefits provided by double gloving

Appendix G

GANTT Chart

Start Date: 9/1/2023

End Date: 4/29/2024

Task Number	Completion Date	Assignment
1	9/19/2022	PICOT
2	9/26/2022	Needs Assessment & Gap Analysis
3	10/10/2022	Background & Significance
4	10/31/2022	Proposal Draft 1
5	11/10/2022	Aims & Theoretical Framework
6	11/12/2022	SWOT/GANTT
7	11/17/2022	Proposal Draft 2
8	11/20/2022	Methods Development, Tools & Outcomes
9	11/25/2022	Data Analysis
10	11/29/2022	Literature Review
11	12/15/2022	Proposal Draft 3
12	1/25/2023	IRB Approval
13	3/1/2023	Data Collection
14	3/30/2023	Complete Analysis
15	4/2/2023	Methods & Analysis Sections
16	4/10/2023	Academic Paper
17	4/15/2023	Abstract & Executive Summary
18	4/20/2023	Revise Project Report
19	4/25/2023	Disseminate EBP
20	4/29/2024	Poster Presentation