

**Implementation of a Double-Gloving Technique to Reduce Anesthesia Workspace**

**Contamination**

by

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A DNP Project Manuscript  
Submitted in Partial Fulfillment of the Requirements for the  
Doctor of Nursing Practice Degree

University of Maryland School of Nursing  
May 2024

Author Note

Correspondence concerning this article should be addressed to Andrea Silvano at [andrea.silvano@umaryland.edu](mailto:andrea.silvano@umaryland.edu). There are no actual or potential conflicts of interest or implications to the implementation of this DNP project.

### Abstract

**Problem:** Anesthesia workspace contamination of oral pathogens poses a direct risk to all patients and healthcare providers. When an anesthesia provider manipulates a patient's airway on induction, blood and secretions contaminate the gloves and become transmitted to the anesthesia workspace. Microorganisms spread through cross-contamination can lead to intraoperative infections and patient complications. Of the anesthesia providers surveyed at a large academic medical center, only 13.3% admitted to double-gloving on induction or removing the contaminated gloves prior to touching the anesthesia workspace. **Purpose:** The purpose of this quality improvement project was to reduce contamination by anesthesia providers with the use of a double-gloving on induction technique in Pod 2 over a 15-week period. **Methods:** Three anesthesia providers led a practice change to implement double-gloving on induction in Pod 2. Project strategies included in-person education (educational video and visual aids), collaboration (weekly site visits and change champions), and evaluation (data collection and analysis). Anesthesia providers collaborated with data collection by completing an anonymous QR code audit tool, evaluating the number of providers performing double-gloving on induction. **Results:** There were 81/761 (10.64%) surveys received, of the 81 total surveys completed, 88.89% (72) of anesthesia providers double-gloved on induction, 96.30% (78) sheathed the laryngoscope blade after use, and 97.53% (79) removed outer gloves prior to touching the anesthesia workspace. **Conclusion:** This quality improvement project successfully reduced contamination risks during induction among anesthesia providers in Pod 2. Following the implementation of a double-gloving on induction technique and various educational and collaborative strategies, compliance with double-gloving increased by 75.9% within the 15-week implementation period.

Keywords: *Double gloving, anesthesia induction, general anesthesia, contamination*

## **Implementation of a Double-Gloving Technique to Reduce Anesthesia Workspace Contamination**

Operating room (OR) contamination of oral micro-organisms and blood-borne pathogens poses a direct risk of infection to all patients and health care providers. When an anesthesia provider manipulates a patient's airway on induction, blood and secretions contaminate his or her gloves and become transmitted to the anesthesia workspace (AW). The contaminated gloves are a direct vector when other equipment is touched, causing opportunistic cross-contamination of the anesthesia machine, reservoir bag, adjustable pressure limiting (APL) valve, breathing circuit, and intravenous (IV) tubing. Bacterial contamination of the AW has been identified as a root cause of 30-day postoperative health care associated infections (HCAI) affecting approximately 16% of all surgical patients (Loftus et al., 2015). Cross-contamination of micro-organisms can lead to higher healthcare costs, longer hospital admissions, and increased patient complications (Birnbach et al., 2015b). One extended hospital admission from a HCAI may average an extra charge of \$20,842 per stay (Jaffe & Moriber, 2019).

Operating room AW contamination has been identified as an infection risk within the 24 operating rooms of a large academic medical center in the northeastern United States. After interviewing 15 anesthesia providers within the institution, 13 admitted to not applying a second glove on the right-hand during induction or removing the contaminated glove prior to touching the anesthesia machine (Figure 1). The stated reasoning was because it was not taught to be part of their induction routine. Although double gloving on induction is an infection prevention guideline of the American Society of Anesthesiologists (ASA) and the American Association of Nurse Anesthesiologists (AANA) there is currently no guideline or formal education addressing double gloving on induction within the organization. Routine use of double-gloving on induction

to reduce cross-contamination in the OR requires education and the implementation of a double-gloving technique to promote change within each providers' standard induction routine.

The purpose of this quality improvement (QI) project was to reduce contamination by anesthesia providers with the use of a double-gloving on induction technique in Pod 2 over a 15-week period. By the end of the 15-week implementation period, the process goals were for 100% of anesthesia providers in Pod 2 to double gloving on induction, sheath the laryngoscope blade after use, and remove outer glove prior to touching the AW.

### **Available Knowledge**

Evidence-based research supports the use of a double-gloving technique to dramatically reduce AW contamination. Birnbach et al. (2015a) and Birnbach et al. (2015b), Level I, quality B and A evidence respectively per the Johns Hopkins Evidence-Based Practice Model for Nursing (JHNEBP), concluded that removing the outer double glove during induction and using it to sheath the laryngoscope blade significantly reduced contamination of the AW. Birnbach et al. (2015a) demonstrated that anesthesia providers alone have the capability to reduce contamination within the operating room by four-fold with the implementation of a double gloving technique. Porteous et al. (2018) and Biddle et al. (2016), Level II, quality A and B respectively, showed that double-gloving during induction reduced AW contamination by up to 50% compared to single gloving. Plemmons et al. (2019), Level II, quality B found that the implementation of infection control guidelines, visual reminders, and education improved compliance of double-gloving on induction and improved overall infection control. Jaffe & Moriber (2019) and Rowlands et al. (2014), Level III, quality A and B respectively, found induction to be a critical period of AW contamination, requiring hand hygiene and clean inner gloves to reduce bacterial transmission. Jaffe & Moriber (2019) demonstrated double-gloving to

be a more effective technique in reducing cross-contamination in comparison to single gloving. The JHNEBP model classifies five of the seven studies used in this review as Levels I & II with Ratings A & B, signifying a high level of overall quality and strength of evidence. Importantly, all studies involved anesthesia providers performing a routine anesthetic induction with airway manipulation, mirroring the targeted population and context within the QI project. High-quality evidence involving similar populations and context strongly support the practice change of adopting a double gloving on induction technique to reduce AW contamination.

### **Rationale**

The use of a process framework such as the Promoting Action on Research Implementation in Health Services (PARiHS) framework serves as an outline for the successful implementation of evidence-based research into clinical practice (White et al., 2021). The PARiHS framework was used for this QI project to guide implementation of a double-gloving on induction technique and decrease overall cross contamination in the OR. The framework consists of three core elements: evidence, context, and facilitation (Figure 2). Evidence is the knowledge and research gathered to support clinical decision-making and change. Double-gloving has been proven through Level I and II evidence to be effective in reducing OR contamination. Context is the setting in which the translation of research will occur. The culture and leadership, the inner components of context, within this academic center value protecting patients from harm by applying the highest standard of evidence-based research into practice. Facilitation is the encouragement and promotion of action to help individuals understand how and why they must change to achieve desired outcomes (White et al., 2021). The implementation of a double-gloving technique empowered anesthesia staff to reduce contamination in the OR to improve patient outcomes and protect patients and providers from harm.

## Methods

### Context

The anesthesiology department within this organization practices as a care team model where an anesthesiologist oversees certified registered nurse anesthetists (CRNA) and anesthesiology residents. Pod 2 encompasses six ORs, reflecting six anesthesia providers at any given time. There are two anesthesia technicians (AT) responsible for the decontamination and turnover of every AW. In a project pre-implementation survey, 86.7% (13 out of 15) of anesthesia providers acknowledged they did not double-glove during induction because it was not taught during their training. At the organization, there is no formal education on double gloving on induction.

Standard procedure to minimize bacterial contamination of the AW involved anesthesia providers placing the laryngoscope blade in a designated biohazard bag after use. The practice was seldomly used as witnessed by random observation. Baseline induction process for anesthesia providers was to don a single pair of gloves, induce, use the scissor technique with right hand to manipulate the patient's airway, insert advanced airway, interact with the AW with contaminated glove, and place contaminated laryngoscope blade on the anesthesia machine (Figure 3). Contaminated gloves and an unsheathed, used laryngoscope blade increase intraoperative contamination and places all patients and healthcare providers at risk.

### Intervention

The evidence-based double-gloving on induction technique was implemented in Pod 2 from August 2023 to December 2023. The desired process was for anesthesia providers to don a single pair of gloves and an extra glove on the right hand, induce, use the scissor technique with right hand to manipulate the patient's airway, insert advanced airway, sheath contaminated

laryngoscope blade inside of outer right glove, and interact with AW with clean inner right glove (Figure 4). Strategies and tactics aided in achieving specific structure and process goals to reduce AW contamination. To ensure accountability and buy-in, the Clinical Site Representative (CSR) and Faculty Sponsor (FS) formally committed to becoming change champions, recognizing infection risk as a major problem in the ORs. Anesthesia staff were educated and empowered to use double-gloving on induction to improve patient outcomes, achieving buy-in. For data collection, the Project Lead (PL) placed QR codes and visual aids at each AW in Pod 2, asking anesthesia providers to complete an anonymous Research Electronic Data Capture (REDCap) survey after each induction (Appendix A). Collaboration and communication were shared in person and virtually through email to the organization's anesthesiology department.

The structure goal was to implement double-gloving education for all anesthesia providers before and throughout QI implementation. An educational email sent to all CRNAs, anesthesia residents and attendings in August 2023 included images comparing single and double gloving contamination and a five-minute educational video created by the PL (Appendix B). The video simulated an anesthetic induction, comparing a single versus a double-gloving technique. A fluorescent gel, used as a surrogate pathogen, was applied to the mannequin's mouth before each induction and blacklight examination of surrogate pathogen transfer sites were compared. Demonstration of how to sheath a used laryngoscope blade with outer right glove was shown. The video was presented at an in-person CRNA meeting in October 2023, made available to all anesthesia providers through email, and as a link after each REDCap survey completion. The PL visited Pod 2 weekly during implementation to provide real-time education and ensure all QR codes and visual aids were available. All anesthesia providers performing an anesthetic induction and manipulating a patient's airway in Pod 2 fulfilled project inclusion criteria.

## **Measurement**

Two functional measures were used to determine structure and process change. The PL was the only data collector to ensure accuracy and minimize error. The first functional measure used to determine a structure change was recording anesthesia providers who received double-gloving education. Completed by the PL through REDCap, it accounts for all anesthesia providers who received education through in-person meetings and discussions (Appendix C). PL was unable to account for anesthesia providers who received education through email alone. The second functional measure used to determine a process change was the completion of an anonymous REDCap survey by anesthesia providers in Pod 2 (Appendix A). The process measure looked to see if anesthesia providers double gloved on induction, if laryngoscope blade was sheathed after use, and if outer glove was removed prior to touching the AW. The survey included an optional comment box for feedback or questions. Random observation of double gloving on induction was not available for this project. Data collection was limited to weekdays due to low case volume and anesthesia provider availability. Monitoring weekly REDCap surveys allowed for the adoption of new interventions to increase self-reporting data capture.

## **Ethical Considerations**

Not Human Subject Research (NHSR) Determination was obtained from the Human Research Protections Office of the University of Maryland Baltimore Institutional Review Board in July 2023. REDCap, a HIPAA compliant, secure web-based data collection program was used to keep data confidential through all steps of collection, storage, and analysis. Educational sessions were held in private areas, and employee data was securely entered into REDCap by the project lead. To protect confidentiality, all surveys were made anonymous and each participant who received education was assigned a non-identifiable Record ID number (Figure 5).

## Results

Over the 15-week implementation period, there were 761 eligible survey opportunities within Pod 2. Of the 761 survey opportunities, a total of 81 surveys were completed for a survey compliance rate of 10.64%. A run chart was used as a quantitative method to analyze survey compliance over the 15-week period. A run chart gives a graphic representation of data over time, in this instance, the Y-axis represents the percentage of anesthesia providers who completed the double-gloving survey in Pod 2 and the X-axis represents weekly plots over the 15-weeks of project implementation. The target goal was for 100% of anesthesia providers in Pod 2 to complete the double-gloving survey after every induction (Figure 6). The double-gloving on induction survey looked to determine the percentage of anesthesia providers who double-gloved on induction, sheathed the laryngoscope blade after use, and removed outer gloves prior to touching the AW. Analysis of these data points demonstrated the anesthesia providers' effectiveness in reducing AW contamination and achieving established process goals.

The nominal survey data was analyzed and inserted into a frequency distribution table (Table 1). Of the 81 anesthesia providers who completed the survey, 88.89% utilized the double-gloving on induction technique (n=72), 96.3% sheathed the laryngoscope blade after use (n=78), and 97.53% removed outer glove prior to touching the AW (n=79). The double-gloving on induction survey included an optional section for anesthesia providers to submit feedback and questions concerning project implementation. The optional comments section of the survey received only three responses from the 81 surveys collected. The first user stated double-gloving "wasn't considered" as an option and the second user "forgot" to double-glove. The third user identified an alternative to double-gloving stating, "didn't double glove but took glove off prior to touching machine."

Forty-three anesthesia providers received in-person double-gloving education and video demonstration (Figure 5), while over 100 anesthesia providers were educated through email and video link alone. Several limitations arose during the implementation of the double-gloving on induction technique. Random observation to directly measure compliance wasn't feasible. Additionally, data collection was restricted to weekdays due to low case volume and anesthesia providers availability on weekends. Time constraints prevented in-person education for anesthesia residents and attendings. These barriers impacted the project's overall reach and data collection methods. Over the 15-week implementation period, the mean number of responses per week was 8.33, with a low of three responses in Week 6 and a peak of 33 responses in Week 8. Week 8 coincided with the Faculty Sponsor (FS) reinforcing project education through email and an in-person CRNA meeting, suggesting a potential positive impact of these interventions. In Week 5, the PL changed strategy to provide in-person reinforcement education to anesthesia providers during anesthesia cases in Pod 2, resulting in the second highest survey response rate (16). Week 12 saw one of the lowest response rates (3) which may have been a result of anesthesia departmental changes leading to lower staff availability. Project implementation did not incur any additional costs to the PL or the organization.

### **Discussion**

Initial site evaluation revealed that 86.7% of anesthesia providers did not perform double-gloving on induction because it was not initially taught to be part of their induction routine. After the 15-week implementation of a double-gloving on induction technique, the project saw a 75.9% increase in double-gloving compliance from a baseline of 13.3%. Educational video dissemination and double-gloving implementation led anesthesia providers within the organization to significantly decrease AW contamination within Pod 2. Evidence-based research

demonstrates that anesthesia providers who practice a double-gloving on induction routine reduce AW contamination by four-fold (Birnbach et al., 2015a). Birnbach et al. (2015b) suggest that double-gloving combined with the sheathing of the laryngoscope blade after use significantly reduces AW contamination compared to double-gloving alone. Encouragingly, 72 anesthesia providers in this project reported adopting both practices, further decreasing AW contamination.

Operating room contamination from oral pathogens spread through contaminated gloves during induction, pose a direct infection risk to both patients and providers. Ultimately, this can lead to an increase in 30-day patient mortality, increased healthcare costs, and longer hospital stays by an average of 10 days. Incorporation of this evidence-based intervention offers a return on investment. Double-gloving on induction may lead to an average cost saving of \$20,842 per extended hospital stay by reducing hospital-acquired infections. Project implementation did not increase costs to the organization or the PL as the intervention only required one additional glove per induction. Survey results reported an alternative anesthesia provider approach to reducing AW not previously considered. There were 72 providers who reported double-gloving on induction, while 79 providers reported removing outer gloves prior to touching the AW. The seven providers may have not “double glove but took glove off prior to touching machine.” Anesthesia providers may be removing the single right glove after endotracheal intubation and interacting with the AW with a bare hand. This is a different way anesthesia providers interact with the patient and the AW, suggesting anesthesia providers have mixed opinions and routines surrounding double-gloving on induction.

There are several potential limitations to the internal validity of the project. Only 10.64% of anesthesia providers in Pod 2 completed the surveys, leading to an underrepresentation of the

behavior of anesthesia providers around double-gloving on induction. The project relied solely on self-reported data because random observation was not available, introducing the possibility of bias. Anesthesia providers may be more likely to self-report following the intervention than reporting actual behavior. Data collection restricted to only weekdays reduces the total actual number of cases and providers performing anesthetic inductions in Pod 2. Time constraints prevented in-person education for all anesthesia residents and attendings, leading to possible variations in knowledge and compliance among different anesthesia provider groups.

Multiple efforts were made to minimize QI project limitations. Numerous educational strategies such as email, video, and in-person sessions were implemented to reach a wider audience at different points in time. Change champions focused on promoting behavior change by increasing staff awareness of infection risks and benefits of double-gloving. Weekly monitoring of survey responses by PL allowed for adjustments to educational interventions to potentially increase self-reporting. Anesthesia providers were informed survey responses would be strictly anonymous and confidential, stressing the importance of anonymity to increase survey compliance. Although project implementation led to a significant increase in double-gloving on induction, reducing AW contamination in Pod 2, further research is required on its direct impact in decreasing hospital acquired infections at this specific organization.

### **Conclusion**

The implementation of a double-gloving technique to reduce anesthesia workspace contamination allows anesthesia providers to protect both patients and providers from harm. Double-gloving on induction is an evidence-based technique that can be easily taught to improve patient safety and outcomes. Despite low survey compliance, of the surveys completed, the implementation of a double-gloving technique was successful as the project saw a 75.9%

increase in double-gloving on induction compliance from a baseline of 13.3%. Utilizing a double-gloving technique encourages anesthesia staff to sheath the laryngoscope blade after use, remove outer glove prior to touching the AW, and further decrease overall contamination of the operating room. Implementing a double-gloving technique during anesthetic induction offers a cost-effective way to prevent hospital-acquired infections, which can add an average of \$20,842 per extended stay.

Approaches to promote spread and sustainability of the double-gloving on induction practice change include continued support from change champions within the organization to implement formal double-gloving education. Of the anesthesia providers surveyed at the site, 86.7% admitted to not performing double-gloving because it was not taught to be part on their induction routine. Collaboration with the University of Maryland School of Nursing, Nurse Anesthesia program can lead to continued spread of the initiative by incorporating the educational video into the curriculum.

Future QI initiatives should incorporate formal double-gloving education for student registered nurse anesthetists (SRNA) at the University of Maryland School of Nursing. Experienced anesthesia providers who do not practice double gloving on induction may have a more difficult time changing their already established induction routine. By incorporating double-gloving as a core educational component into an SRNA curriculum, future CRNAs will be well-equipped and prepared to seamlessly integrate this practice into every induction routine.

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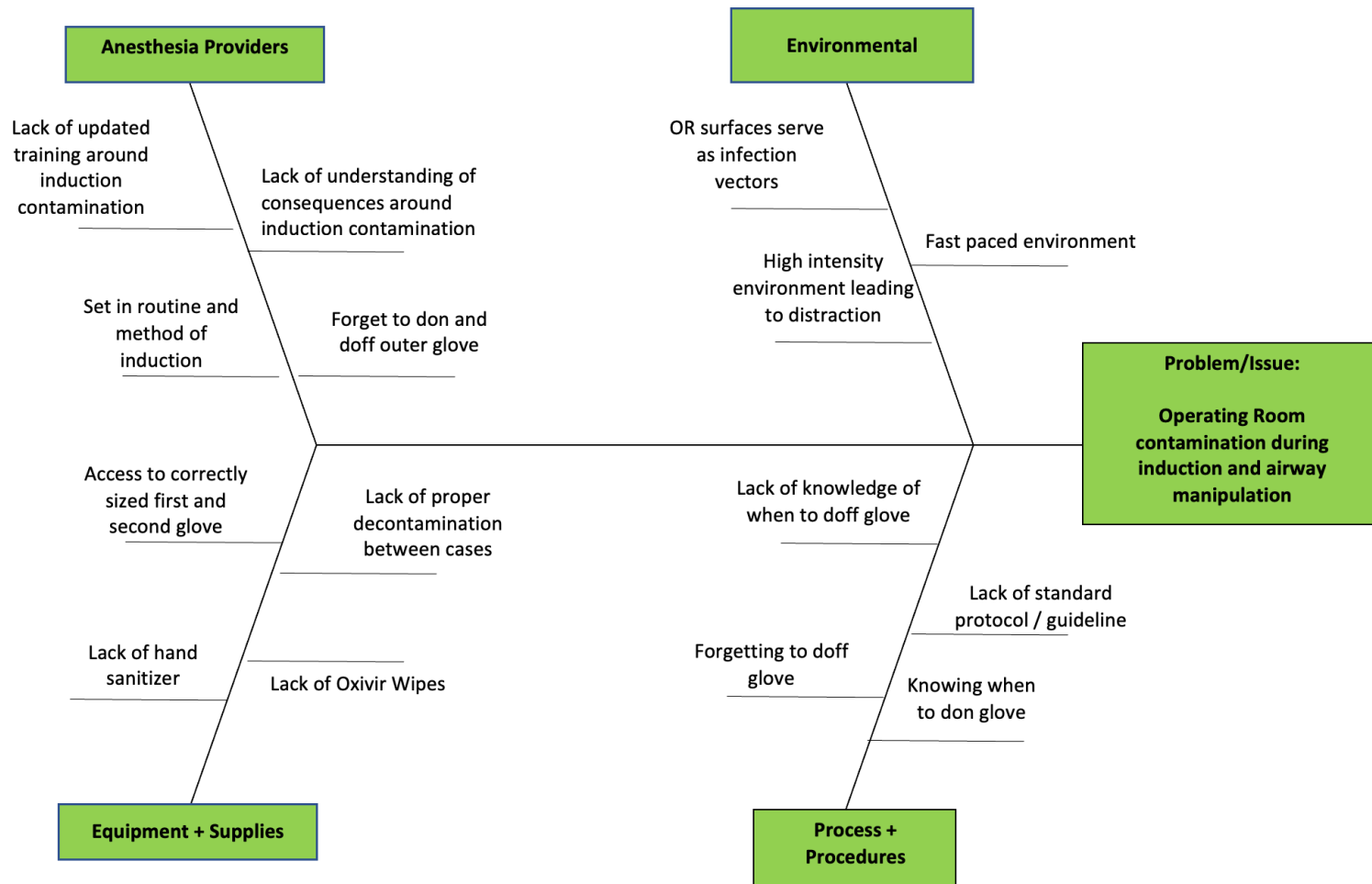
*Policy and Systems*, 19(1), 38. <https://doi.org/10.1186/s12961-020-00662-1>

**Table 1***Double-Gloving on Anesthetic Induction Results (n=81)*

<b>Variable</b>	<b>n</b>	<b>%</b>
<b>Was a Double-Gloving Technique Used on Induction?</b>		
Yes	72	<b>88.89</b>
No	9	11.1
<b>Was Laryngoscope Blade Sheathed After Use?</b>		
Yes	78	<b>96.30</b>
No	3	3.7
<b>Were Outer Gloves Removed Prior to Touching the AW?</b>		
Yes	79	<b>97.53</b>
No	2	2.5

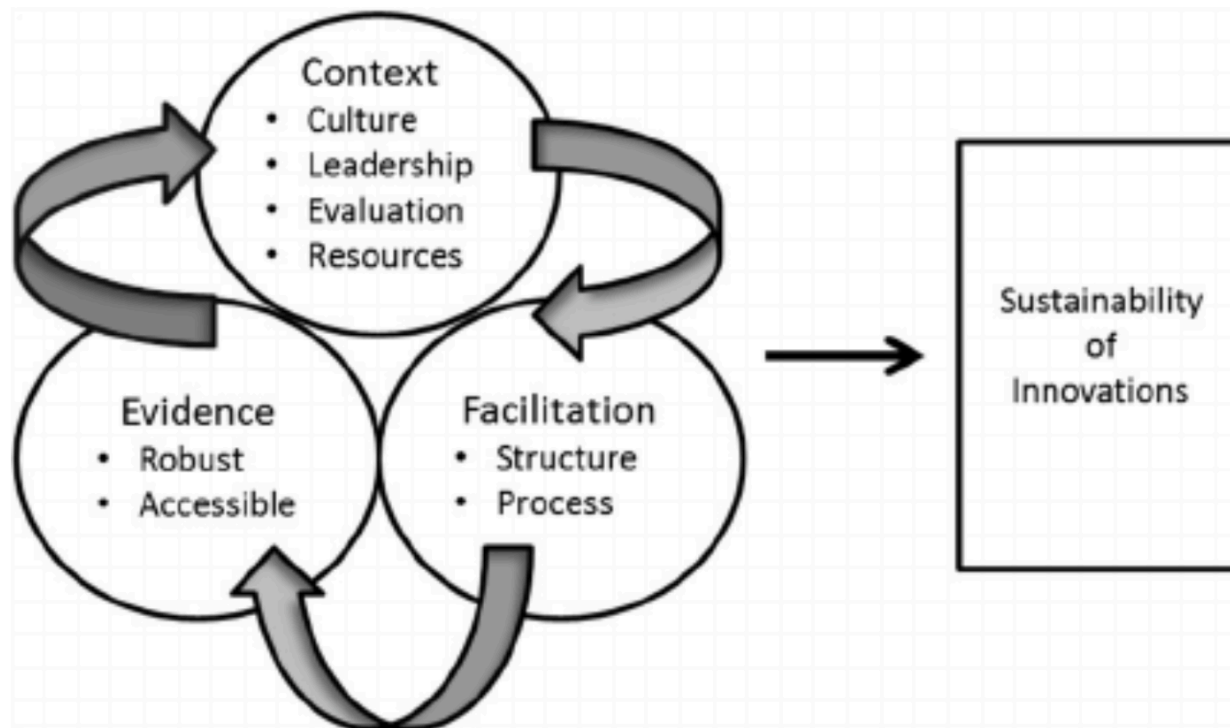
Figure 1

*Fishbone Diagram: Double-Gloving on Anesthetic Induction*



**Figure 2**

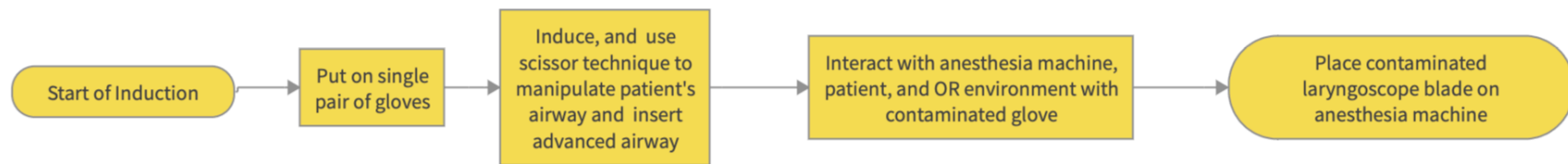
*Promoting Action on Research Implementation in Health Services (PARiHS) Framework*



*Note.* From University of Maryland School of Nursing, NDNP 804, Module 8: Theory, Model or Framework Identification. Rycroft-Malone, J. (2010). Promoting on Research Implementation in Health Services (PARISH). In J. Rycroft-Malone & T. Bucknall (Eds.), Models and frameworks for implementing evidence-based practice: Linking evidence to action (pp. 109-136). Oxford: Wiley-Blackwell.

**Figure 3**

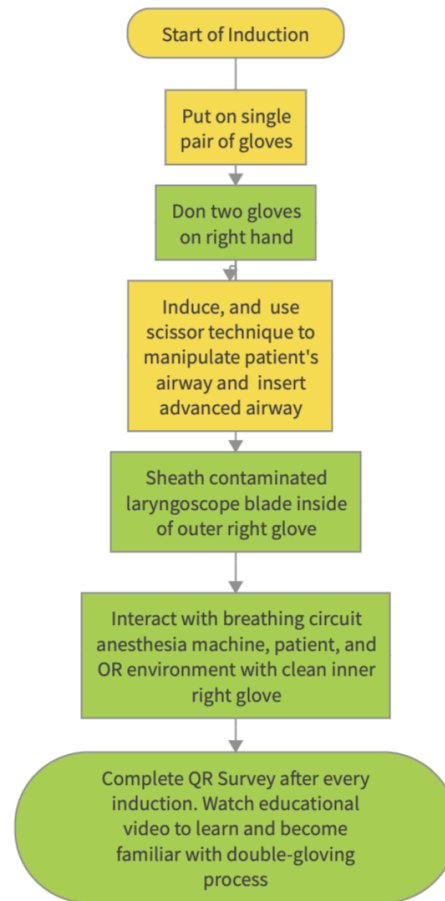
*Current Process Map of Anesthetic Induction in Pod 2*



*Note.* Yellow: Current Process Steps.

**Figure 4**

*Desired Process Map for Anesthetic Induction in Pod 2*



*Note.* Yellow: Current and continued process. Green: New, desired process steps.

**Figure 5**

*Educational Audit Tool Results*

**Data Exports, Reports, and Stats**

**Number of results returned: 43**

Total number of records queried: 43

**Educational Audit Tool-Structure Measure**

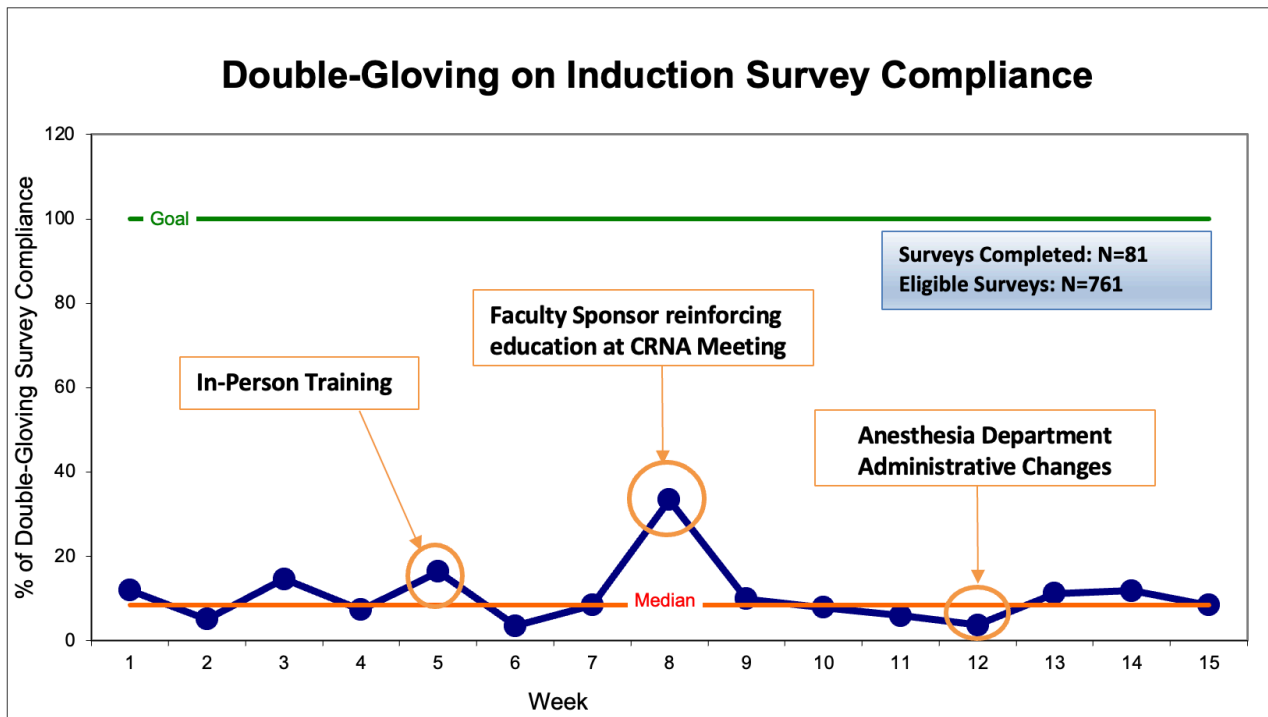
Record ID <small>record_id</small>	Provider Identification Code <small>provider_code</small>	Did the provider receive Double-Gloving Education? <small>education</small>
<a href="#">1</a>	1	Yes (1)
<a href="#">2</a>	2	Yes (1)
<a href="#">3</a>	3	Yes (1)
<a href="#">4</a>	4	Yes (1)
<a href="#">5</a>	5	Yes (1)
<a href="#">6</a>	6	Yes (1)
<a href="#">7</a>	7	Yes (1)
<a href="#">8</a>	8	Yes (1)
<a href="#">9</a>	9	Yes (1)
<a href="#">10</a>	10	Yes (1)
<a href="#">11</a>	11	Yes (1)
<a href="#">12</a>	12	Yes (1)
<a href="#">13</a>	13	Yes (1)
<a href="#">14</a>	14	Yes (1)
<a href="#">15</a>	15	Yes (1)
<a href="#">16</a>	16	Yes (1)
<a href="#">17</a>	17	Yes (1)
<a href="#">18</a>	18	Yes (1)
<a href="#">19</a>	19	Yes (1)
<a href="#">20</a>	20	Yes (1)
<a href="#">21</a>	21	Yes (1)
<a href="#">22</a>	22	Yes (1)
<a href="#">23</a>	23	Yes (1)
<a href="#">24</a>	24	Yes (1)
<a href="#">25</a>	25	Yes (1)
<a href="#">26</a>	26	Yes (1)
<a href="#">27</a>	27	Yes (1)
<a href="#">28</a>	28	Yes (1)

**Figure 5***Educational Audit Tool Results(continued)*

<u>29</u>	29	Yes (1)
<u>30</u>	30	Yes (1)
<u>31</u>	31	Yes (1)
<u>32</u>	32	Yes (1)
<u>33</u>	33	Yes (1)
<u>34</u>	34	Yes (1)
<u>35</u>	35	Yes (1)
<u>36</u>	36	Yes (1)
<u>37</u>	37	Yes (1)
<u>38</u>	38	Yes (1)
<u>39</u>	39	Yes (1)
<u>40</u>	40	Yes (1)
<u>41</u>	41	Yes (1)
<u>42</u>	42	Yes (1)
<u>43</u>	43	Yes (1)

**Figure 6**

*Double-Gloving on Induction Survey Compliance Run Chart*



Richard Scoville, PhD. (2016) *Run Chart Template*.

**Appendix A**

## Double-Gloving on Induction Audit Tool

Page 1

**Double-Gloving on Anesthetic Induction**

Please complete this survey on every induction.

Thank you!

- 
- 1) Date \_\_\_\_\_
- 
- 2) What OR are you working in?  OR 14  
 OR 15  
 OR 16  
 OR 17  
 OR 18  
 OR 19
- 
- 3) Was a double-gloving technique used on induction?  Yes  
 No
- 
- 4) Was laryngoscope blade sheathed after use?  Yes  
 No
- 
- 5) Were outer gloves removed prior to touching the anesthesia workspace?  Yes  
 No
- 
- 6) If Double-Gloving not done, please state why:  
Provide Feedback and/or Questions \_\_\_\_\_



**Appendix B**

Mannequin Simulated Double-Gloving on Induction Educational Video

**[Implementation of a Double-Gloving Technique to Reduce Anesthesia Workspace Contamination](#)**

Click on the link above to view Educational Video created by PL.

### Appendix C

#### Education Audit Tool

## Double-Gloving Education Audit Tool

Page 1

Complete audit for every individual who received Double-Gloving Education.

- 
- 1) Name \_\_\_\_\_
- 
- 2) Provider Identification Code \_\_\_\_\_
- 
- 3) Did the provider receive Double-Gloving Education?  Yes  
 No



## Appendix D

## Evidence Review

<b>Citation:</b> Biddle, C., Robinson, K., Pike, B., Kammerman, M., Gay, B., & Verhulst, B. (2016). Quantifying the rambunctious journey of the anesthesia provider's hands during simulated, routine care. American Journal of Infection Control, 44(8), 873–878. <a href="https://doi.org/10.1016/j.ajic.2016.02.014">https://doi.org/10.1016/j.ajic.2016.02.014</a>	<b>Level and Quality:</b>  <b>II-B</b>
<b>Purpose or Hypothesis</b>	The purpose of this study was to quantify how a surrogate pathogen would disperse from a simulated patient's mouth to the anesthesia workspace during routine induction, to examine the and test the hypothesis that there would be less contamination sites by anesthesia provider who use a double-gloving technique, and to examine how effective anesthesia equipment disinfection is between cases.
<b>Type of Evidence Research Design</b>	Quantitative observational study
<b>Sample Population, Size, Setting</b>	<p><b>Sampling Technique:</b> Convenience. <b>Eligible Participants:</b> Experienced anesthesia providers  <b>Setting:</b> Virginia Commonwealth University (VCU) Center for Research in Human Simulation, approved by VCU Institutional Review Board (IRB).  <b>Excluded:</b> Study does not identify participant exclusion.  <b>Accepted:</b> 20 experienced anesthesia providers. The 20 subjects were randomized and divided into two groups.  <b>Control:</b> Group 1 (n=10) wore single pair of gloves throughout induction and intubation. No CONSORT diagram present. No attrition.  <b>Intervention:</b> Group 2 (n=10) wore double-gloves through induction and intubation and removed outer gloves prior to attaching breathing circuit to endotracheal tube. Outer gloves and laryngoscope blade were placed in a collecting basin. No CONSORT diagram present or attrition.  <b>Power analysis/Achieved:</b> Power to detect significant differences between groups was 0.94. With this effect size, 7 subjects were sufficient to achieve 80% power. Power analysis achieved. <b>Group Homogeneity:</b> Both groups are experienced anesthesia providers. No other group homogeneity information is given.</p>
<b>Intervention Procedures</b>	<p><b>Control Protocol:</b> Mannequin's tongue and incisors were inoculated with 1.5mL of dye gel, an analog for biological material, mimicking a saliva-like consistency. Group 1 instructed to perform a routine anesthetic induction and intubation with single gloves.  <b>Intervention Protocol:</b> Mannequin's tongue and incisors were inoculated with 1.5mL of dye gel, an analog for biological material, mimicking a saliva-like consistency. Group 2 instructed to perform a routine anesthetic induction and intubation where outer glove pair is removed immediately after the placement of the endotracheal tube and before connecting breathing circuit to endotracheal tube.  <b>Treatment Fidelity:</b> All forty participants followed the same protocol. The patient was simulated by SimMan 3G and 1.5mL of clear, odorless fluorescent marking gel, analog to biological fluids, was applied to the mannequin's tongue and incisors. A Wood's lamp, emitting ultraviolet light was used to identify the dye and quantify the dispersion of biological material. Both groups were unaware of present dye gel. Technician blinded to single or double glove use on induction examined the mannequin, intravenous lines, cables, anesthesia circuit, supply cart, and machine using ultraviolet light. This was equally done for both control and intervention groups.</p>
<b>Primary Outcome and Measures</b>	<p><b>Dependent Variable:</b> Dispersion of dye from mannequin's oral cavity to anesthesia environment sites was caused by the actions of the anesthesia provider and thus considered the outcome variable.  <b>DV Measure:</b> A standardized photograph data collection tool was used to inventory areas of contamination. Collection tool identified as having high face validity. Control and intervention group performance was plotted using regression analysis and rate of contamination was compared with the use of parametric statistics. A 2 sample t test was performed to identify differences in dispersion sites as well as Fisher exact tests.</p>
<b>Results/Conclusions</b>	<p><b>Statistical Results:</b> Average Group 1 contamination sites was 16.0 (SEM 0.89) in comparison to a Group 2 average of 7.6 (SEM=0.85), P &lt;0.001.  <b>Conclusion:</b> The use of double gloving during routine anesthetic induction is associated with less spread of anesthesia workstation contamination by more than 50% in comparison to single gloving during routine anesthetic induction. In between case cleaning did not fully remove contaminant, indicating biological material from one patient may transfer easily to the next. Models which simulate clinical events such as induction can help inform clinical practice.</p>

**Appendix D**  
Evidence Review

<p><b>Citation:</b> Birnbach, D. J., Rosen, L. F., Fitzpatrick, M., Carling, P., Arheart, K. L., &amp; Munoz-Price, L. S. (2015a). Double Gloves: A Randomized Trial to Evaluate a Simple Strategy to Reduce Contamination in the Operating Room. <i>Anesthesia &amp; Analgesia</i>, 120(4), 848–852. <a href="https://doi.org/10.1213/ANE.0000000000000230">https://doi.org/10.1213/ANE.0000000000000230</a></p>	<p><b>Level and Quality:</b> <b>I-B</b></p>
<p><b>Purpose or Hypothesis</b></p>	<p>The purpose of this research study was to determine whether the use of two sets of gloves during induction with outer set removed immediately after intubation reduces the risk of bacterial contamination in the operating room.</p>
<p><b>Type of Evidence Research Design</b></p>	<p>Double blinded, controlled, randomized trial</p>
<p><b>Sample Population, Size, Setting</b></p>	<p><b>Sampling Technique:</b> Convenience. <b>Eligible Participants:</b> Anesthesiology residents PGY2 through PGY4  <b>Setting:</b> University of Miami-Jackson Memorial Hospital Center for Patient Safety, state-of-the-art simulation center. Study exempt by the University of Miami Miller School of Medicine IRB.  <b>Excluded:</b> Study does not identify participant exclusion. <b>Accepted:</b> 41 anesthesiology residents PGY2 through PGY4. The study was randomized by random number generation as to who wore single or double gloves.  <b>Control:</b> 11 simulation sessions with the intubating resident wearing single gloves. No CONSORT diagram present. No attrition.  <b>Intervention:</b> 11 simulation sessions with the intubating resident wearing double gloves. No CONSORT diagram present. No attrition.  <b>Power analysis/Achieved:</b> No power analysis use since it was an exploratory study. Sample size was limited by the number of participants. A significance level of 0.01 was used to determine statistical significance due to there not being a previous power analysis.  <b>Group Homogeneity:</b> Both groups are anesthesiology residents PGY2 through PGY4. No other group homogeneity is mentioned.</p>
<p><b>Intervention Procedures</b></p>	<p><b>Control Protocol:</b> Mannequin lips and inside of mouth coated with 0.5mL fluorescent marking gel as surrogate for oral cavity pathogens or blood. Intubating resident instructed to perform an anesthetic induction and intubation with single gloves to be removed at the completion of the scenario if they had not done so on their own.  <b>Intervention Protocol:</b> Mannequin lips and inside of mouth coated with 0.5mL fluorescent marking gel as surrogate for oral cavity pathogens or blood. Intubating resident instructed to perform an anesthetic induction and intubation where outer glove pair is removed immediately after the placement of the endotracheal tube and before contact with their surroundings.  <b>Treatment Fidelity:</b> All participants followed the same protocol. Mannequin lips and inside of mouth coated with 0.5mL fluorescent marking gel as surrogate for oral cavity pathogens or blood was placed for both the control and intervention groups. Observer blinded to single or double glove use on induction examined all sites using ultraviolet light. The OR was cleaned between all cases using alcohol-based hand rub and soap to remove all prior fluorescent markers. All residents were unaware of fluorescent marking gel use on mannequin.</p>
<p><b>Primary Outcome and Measures</b></p>	<p><b>Dependent Variable:</b> Number of contamination sites at the end of the simulation  <b>DV Measure:</b> Forty sites of potential contamination were evaluated by an observer blind to single or double glove use on induction. Contamination was evaluated using an ultraviolet light and given a score of zero if no fluorescence present or 1 point for positive fluorescent. The proportion of objects positive for fluorescent markers based on single versus double glove use was analyzed using X<sup>2</sup> or Fisher exact test. Poisson regression was used to analyze the total number of contaminated sites. SAS 9.3 was used for all analyses.</p>
<p><b>Results/Conclusions</b></p>	<p><b>Statistical Results:</b> The difference in the rate of operating room contamination sites between anesthesiology residents who wore single gloves (20.3 ± 1.4) versus double gloves (5.0 ± 0.7; P&lt;0.001) on induction is clinically and statistically significant.  <b>Conclusion:</b> Double gloving in comparison to single gloving during laryngoscopy and endotracheal intubation, with removal of outer set immediately after intubation, dramatically reduces intraoperative contamination.</p>

**Appendix D**  
Evidence Review

<p><b>Citation:</b> Birnbach, D. J., Rosen, L. F., Fitzpatrick, M., Carling, P., Arheart, K. L., &amp; Munoz-Price, L. S. (2015b). A New Approach to Pathogen Containment in the Operating Room: Sheathing the Laryngoscope After Intubation. <i>Anesthesia &amp; Analgesia</i>, 121(5), 1209–1214. <a href="https://doi.org/10.1213/ANE.0000000000000854">https://doi.org/10.1213/ANE.0000000000000854</a></p>		<p><b>Level and Quality:</b>  <b>I-A</b></p>
<p><b>Purpose or Hypothesis</b></p>	<p>The purpose of this research study was to evaluate if contamination of the intravenous (IV) hubs, anesthesia work area, and patient could be reduced by using 2 sets of gloves for induction and sheathing the laryngoscope blade and handle in one of the outer gloves immediately following endotracheal intubation in a simulated OR.</p>	
<p><b>Type of Evidence Research Design</b></p>	<p>Double blinded, controlled, randomized trial</p>	
<p><b>Sample Population, Size, Setting</b></p>	<p><b>Sampling Technique:</b> Convenience. <b>Eligible Participants:</b> Anesthesiology residents PGY2 through PGY4  <b>Setting:</b> University of Miami-Jackson Memorial Hospital Center for Patient Safety. Study exempt by the University of Miami, Miller IRB.  <b>Excluded:</b> Study does not identify participant exclusion. <b>Accepted:</b> 45 anesthesiology residents PGY2 through PGY4. Participants randomized by random number generation, to single gloves, double gloves, or double gloves with sheathing of laryngoscope groups.  <b>Control:</b> 15 simulation sessions with the intubating resident wearing single gloves. No CONSORT diagram present. No attrition.  <b>Intervention:</b> 15 simulation sessions with the intubating resident wearing double gloves. No CONSORT diagram present. No attrition.  <b>Intervention:</b> 15 simulation sessions with the intubating resident wearing double gloves and sheathing of laryngoscope. No CONSORT diagram present. No attrition. <b>Power analysis/Achieved:</b> Power analysis determined on the end point of identifying a difference in IV hub contamination. A 90% power at the 0.05 2-sided alpha level required a sample size of 15 per group. Power analysis met.  <b>Group Homogeneity:</b> All three groups contained anesthesiology residents PGY2 -PGY4. Level of training and sex were the only co-varieties mentioned.</p>	
<p><b>Intervention Procedures</b></p>	<p><b>Control (Single Glove) Protocol:</b> Group instructed to only wear a single pair of gloves during induction sequence and intubation.  <b>Intervention (Double Glove) Protocol:</b> Group instructed to wear a double pair of gloves during induction sequence and intubation.  <b>Intervention (Double Glove with Sheathing) Protocol:</b> Group instructed to wear double pair of gloves during induction and intubation. Participants received instruction and time to practice sheathing laryngoscope blade with use of double gloves.  <b>Treatment Fidelity:</b> All participants followed the same protocol. Human Patient Simulator (HPS) lips and inside of mouth coated with 0.5mL fluorescent marking gel as surrogate for oral cavity pathogens was placed for both the control and intervention groups. Each induction and intubation scenario set to last approximately six minutes. An observer, different than the investigator who randomly allocated the residents, examined after each induction 25 prior identified sites using ultraviolet light for contamination. The OR was cleaned between all simulations using alcohol-based hand rub and soap and water to remove all prior fluorescent markers. To ensure proper decontamination, the observer would examine the OR with the blacklight for any residue marker. All anesthesiology residents were blind to the use of fluorescent marking gel use on the HPS.</p>	
<p><b>Primary Outcome and Measures</b></p>	<p><b>Dependent Variable:</b> Proportion of contamination detected on each of the 25 pre-determined sites. (7 on the patient, 18 in the intraoperative setting)  <b>DV Measure:</b> Twenty-five sites of potential contamination were evaluated by an observer blind to all groups. Proportion of contamination per site reported as percents with 95% Clopper-Pearson confidence intervals. Exact X<sup>2</sup> tests conducted for differences in contamination proportion between groups. Bonferroni adjustment was applied to resulting P values and Poisson regression used.</p>	
<p><b>Results/Conclusions</b></p>	<p><b>Statistical Results:</b> Group rates of contamination of the IV hub show (single gloves, 93%[95% CI,68-100]; double gloves with no sheathing, 80%[52-96%]; double gloves with sheathing, 0[0-22]) to be statistically and clinically significant (P &lt;0.001). Double gloves with no sheathing had significantly more contaminated patient and anesthesia work area sites than double gloves with sheathing (P=0.002; P&lt;0.001).  <b>Conclusion:</b> Double gloving with removal of outer pair and sheathing of laryngoscope blade and handle will significantly reduce contamination of the IV hub, patient, and anesthesia work area in comparison to single gloving or double gloving but not sheathing the laryngoscope blade.</p>	

**Appendix D**  
Evidence Review

<b>Citation:</b> Jaffe, G., & Moriber, N. (2019). Use of a Double Gloving Technique to Decrease Cross-Contamination by Anesthesia Providers. <i>American Association of Nurse Anesthetists</i> , 87(4), 307-312		<b>Level and Quality:</b> <b>III-A</b>
<b>Purpose or Hypothesis</b>	The purpose of this study is to evaluate the use of the double gloving technique by anesthesia providers in a non-simulated patient care setting in decreasing cross-contamination.	
<b>Type of Evidence Research Design</b>	Prospective, Quasi-experimental study	
<b>Sample Population, Size, Setting</b>	<p><b>Sampling Technique:</b> Convenience. <b>Eligible Participants:</b> Student and Certified Registered Nurse Anesthetists (SRNA and CRNA)  <b>Setting:</b> Approved by IRB at an inner-city, level 2 trauma center.  <b>Excluded:</b> Study does not identify participant exclusion. <b>Accepted:</b> 5 second-year SRNA, 13 third-year SRNA, 12 CRNA.  <b>Control:</b> 36 participants and anesthesia equipment evaluated prior to educational session on double gloving (Time 1). Participant demographics available but no CONSORT diagram present. No attrition for Time 1.  <b>Intervention:</b> Same 36 participants and anesthesia equipment evaluated post educational session on double gloving at week 1 (Time 2) and again 1 month later (Time 3). 6 participants did not follow appropriate double gloving technique at Time 2 and were removed from study. No CONSORT diagram present.  <b>Power analysis/Achieved:</b> Power of 0.8 yielded a minimum sample of 30 participants. There were 36 participants. Power analysis met.  <b>Group Homogeneity:</b> Participant demographics available but no CONSORT diagram present, no P values present to identify statistic homogeneity.</p>	
<b>Intervention Procedures</b>	<p><b>Control Protocol:</b> Equipment contamination assessed with a Wood's ultraviolet black light pre and post induction. Equipment cleaned before anesthetic induction with multipurpose disinfectant wipes. Participants and environment evaluated prior to educational session on double gloving (Time 1).  <b>Intervention Protocol:</b> Equipment contamination assessed with a Wood's ultraviolet black light pre and post induction. Equipment cleaned before anesthetic induction with multipurpose disinfectant wipes. Participants and environment evaluated 1 week after educational session on double gloving (Time 2) and evaluated 1 month after educational session on double gloving (Time 3).  <b>Treatment Fidelity:</b> All participants followed the same protocol. All OR equipment was cleaned before the start of induction, equipment contamination was assessed pre and post induction with the use of an ultraviolet black light Wood's lamp. All participants received the same education.</p>	
<b>Primary Outcome and Measures</b>	<p><b>Dependent Variable:</b> Environmental contamination sites after induction pre and post education at three different time intervals.  <b>DV Measure:</b> Amount of contamination present was documented as 0%, 25%, 50%, 75% or 100% contaminated to allow for even comparisons. After induction contamination site rate analysis using G*Power software was conducted across all three groups using a related-samples Friedman test, with a moderate effect size of 0.25 and P value less than 0.05.</p>	
<b>Results/Conclusions</b>	<p><b>Statistical Results:</b> The related-samples Friedman test by ranks showed statistically significant decreases in contamination of the vaporizers (<math>P &lt; 0.001</math>), reservoir bag (<math>P &lt; 0.001</math>), and anesthesia circuit (<math>P &lt; 0.001</math>) with the use of a double gloving technique on induction.  <b>Conclusion:</b> Double gloving is a more effective technique in reducing cross-contamination in the operating room in comparison to single gloving.</p>	

**Appendix D***Evidence Review*

<b>Citation:</b> Plemmons, M. M., Marcenaro, J., Oermann, M. H., Thompson, J., & Vacchiano, C. A. (2019). Improving infection control practices of nurse anesthetists in the anesthesia workspace. <i>American Journal of Infection Control</i> , 47(5), 551–557. <a href="https://doi.org/10.1016/j.ajic.2018.12.009">https://doi.org/10.1016/j.ajic.2018.12.009</a>		<b>Level and Quality:</b>  <b>II-B</b>
<b>Purpose or Hypothesis</b>	The purpose of this study was to determine if implementation of standardized infection control guidelines and education addressing evidence-based infection prevention can improve infection control practices within the anesthesia workspace (AW).	
<b>Type of Evidence Research Design</b>	Quasi-experimental study, pre and post intervention design	
<b>Sample Population, Size, Setting</b>	<p><b>Sampling Technique:</b> Convenience <b>Eligible Participants:</b> 35 nurse anesthetists (CRNA) providing majority of anesthetics in main operating suites</p> <p><b>Setting:</b> 957-bed medical center in the Southeastern United States</p> <p><b>Excluded:</b> Not specified. <b>Accepted:</b> 35 nurse anesthetists providing majority of anesthetics in main operating suites</p> <p><b>Control:</b> Pre-implementation compliance of infection control (hand hygiene on airway manipulation [double-gloving], separate clean/contaminated areas, and clean medication administration) during induction.</p> <p><b>Intervention:</b> Compliance of induction infection control (3 anesthesia areas: hand hygiene after airway manipulation, separate clean/contaminated areas, and clean medication administration) after the implementation of education, visual reminders, and standardized infection control guidelines.</p> <p><b>Power analysis/Achieved:</b> No power analysis discussed in this study.</p> <p><b>Group Homogeneity:</b> There was no differentiation between nurse anesthetists.</p>	
<b>Intervention Procedures</b>	<p><b>Control Protocol:</b> Single blind direct observation of patient care-related hand hygiene of nurse anesthetists during induction before infection control intervention. Self-assessment tool also administered to determine provider baseline practice.</p> <p><b>Intervention Protocol:</b> A 30-minute education session presented at a monthly CRNA meeting and emailed. Repeated 2 months later. Single blind direct CRNA observation of patient care-related hand hygiene [double-gloving], separate clean/contaminated areas, and clean medication administration during induction 3 weeks and 3 months after infection control intervention. (staff education, visual reminders, implementation of infection control guidelines).</p> <p><b>Treatment Fidelity:</b> All participants followed the same protocol. All participants were blind to what aspects of induction were being observed at baseline, 3 weeks, and 3 months after intervention implementation.</p>	
<b>Primary Outcome and Measures</b>	<p><b>Dependent Variable:</b> Compliance percentage with infection control after education and protocol implementation</p> <p><b>DV Measure:</b> Using the Fisher exact test, CRNA percent compliance was calculated for the 3 anesthesia areas and compared at baseline, 3 weeks, and 3 months post intervention.</p>	
<b>Results/Conclusions</b>	<p><b>Statistical Results:</b> 95 single blind observations during the 3 observation periods. 26.2% increase in hand-hygiene compliance after airway instrumentation (<math>p=0.29</math>). A 71.9% increase in CRNA separating clean and contaminated items in the workspace (<math>p=.0001</math>). <b>Conclusion:</b> Infection control guidelines, visual reminders, and education improve infection control compliance such as double-gloving on induction among CRNA and encourage best evidence-based practices.</p>	

**Appendix D**  
Evidence Review

<p><b>Citation:</b> Porteous, G. H., Bean, H. A., Woodward, C. M., Beecher, R. P., Bernstein, J. R., Wilkerson, S., Porteous, I., &amp; Hsiung, R. L. (2018). A Simulation Study to Evaluate Improvements in Anesthesia Work Environment Contamination After Implementation of an Infection Prevention Bundle: Anesthesia &amp; Analgesia, 127(3), 662–670. <a href="https://doi.org/10.1213/ANE.0000000000002764">https://doi.org/10.1213/ANE.0000000000002764</a></p>		<p><b>Level and Quality:</b>  <b>II-A</b></p>
<p><b>Purpose or Hypothesis</b></p>	<p>The purpose of this study is to evaluate the effectiveness of an intervention infection prevention bundle in reducing fluorescent contamination tracers in an anesthesia work environment (AWE).</p>	
<p><b>Type of Evidence Research Design</b></p>	<p>Quasi-experimental study</p>	
<p><b>Sample Population, Size, Setting</b></p>	<p><b>Sampling Technique:</b> Convenience. <b>Eligible Participants:</b> Anesthesia residents PGY3-PGY4, CRNAs, and attending anesthesiologists <b>Setting:</b> Virginia Mason Simulation Center. Study design exempt by IRB of the Benaroya Research Institute at Virginia Mason Medical Center. <b>Excluded:</b> Participants excluded if they applied double glove on baseline case. No participants were excluded. <b>Accepted:</b> 25 anesthesia providers enrolled in nonrandomized simulation scenarios. Coin toss randomized participants to scenario A or B. <b>Control (No Bundle):</b> All 25 anesthesia providers participated in scenario A or B without bundle. No CONSORT diagram. No attrition. <b>Intervention (Infection Prevention Bundle):</b> All 25 anesthesia providers participated in scenario A or B with infection prevention bundle. No CONSORT diagram present. No attrition. <b>Power analysis/Achieved:</b> A power of 0.8, a 2-tailed alpha of 0.05, and effect size of 0.6, a sample size of 22 was needed. There were 25 participants. Power analysis met. <b>Group Homogeneity:</b> All participants are generalizable as they are all anesthesia providers. Differences are draw by years of experience and type of anesthesia provider.</p>	
<p><b>Intervention Procedures</b></p>	<p><b>Control Protocol:</b> Baseline simulated case, whether scenario A or B, all participants conducted usual patient care without bundle. <b>Intervention Protocol:</b> In the intervention simulated case, whether scenario A or B, all participants were instructed to execute the infection prevention bundle of double gloving before intubation, all contaminated equipment kept in one area, and performing hand hygiene before touching anesthesia cart. <b>Treatment Fidelity:</b> All participants followed the same protocol. Laerdal SimMan manikin tongue and oropharynx were coated with 2mL of ultraviolet fluorescent gel to simulate bacterial contamination. The OR was cleaned between all cases using germicidal wipes to remove all prior fluorescent markers and inspected with UV source. All participants were blind to fluorescent gel use on the manikin.</p>	
<p><b>Primary Outcome and Measures</b></p>	<p><b>Dependent Variable:</b> Total number of contaminated AWE sites by a subject post scenario completion. <b>DV Measure:</b> Twenty predetermined AWE sites were evaluated by two investigators using photography. Subject contamination score was evaluated using an ultraviolet light and given a score of one per site contaminated A blind observer scored each photograph. Maximum score possible is 20. Poisson regression with mixed effects model was used to analyze bundle effect on subject contamination score. Site-specific contamination scores were compared using Fisher exact test.</p>	
<p><b>Results/Conclusions</b></p>	<p><b>Statistical Results:</b> Infection prevention bundle was associated with subject contamination score of 4 (95% CI, 2.2-5.6; P&lt;.001), a statistically significant 27% reduction in contamination score between baseline scenario and infection prevention bundle scenario. <b>Conclusion:</b> The implementation of an infection prevention bundle, including hand hygiene, designating a contaminated area for equipment, and double gloving on induction can help to reduce AWE contamination.</p>	

**Appendix D***Evidence Review*

<b>Citation:</b> Rowlands, J., Yeager, M. P., Beach, M., Patel, H. M., Huysman, B. C., & Loftus, R. W. (2014). Video observation to map hand contact and bacterial transmission in operating rooms. <i>AJIC: American Journal of Infection Control</i> , 42(7), 698–701. <a href="https://doi.org/10.1016/j.ajic.2014.02.021">https://doi.org/10.1016/j.ajic.2014.02.021</a>		<b>Level and Quality:</b>  <b>III-B</b>
<b>Purpose or Hypothesis</b>	The purpose of the study was to observe and evaluate anesthesia provider hand hygiene through video to map hand bacterial transmission in the anesthesia work environment (AWE).	
<b>Type of Evidence Research Design</b>	Non-experimental study	
<b>Sample Population, Size, Setting</b>	<p><b>Sampling Technique:</b> Convenience. <b>Eligible Participants:</b> Anesthesia providers within the operating room scheduled for surgery requiring general anesthesia with airway manipulation.</p> <p><b>Setting:</b> Dartmouth-Hitchcock Medical Center. IRB informed and approved through verbal and written consent.</p> <p><b>Excluded:</b> Study does not identify participant exclusion.</p> <p><b>Accepted:</b> 10 anesthesia providers, one anesthesia provider per operating room (surgical case)</p> <p><b>Control (Phase 1):</b> 5 surgical cases, no attrition. No CONSORT diagram present.</p> <p><b>Intervention (Phase 2):</b> 5 surgical cases, no attrition. No CONSORT diagram present.</p> <p><b>Power analysis/Achieved:</b> No power analysis addressed.</p> <p><b>Group Homogeneity:</b> No group homogeneity is mentioned.</p>	
<b>Intervention Procedures</b>	<p><b>Control Protocol:</b> Anesthesia providers observed to identify hand contact between provider and AWE. 90 objects identified.</p> <p><b>Intervention Protocol:</b> Of the 90 object previously identified, 20 were analyzed for pathogen culture using sterile polyester fiber-tipped applicator swabs moistened with sterile transport medium rolled over repeatedly over the surface of the object. Blood agar plates used to detect both gram positive and negative bacteria were incubated at 37C for 48 hours. All 20 surfaces were aggressively decontaminated before the start of a subsequent set of 5 surgical cases. Cultures obtained at baseline before surgery, at 30-minute intervals during surgery, and at the end of surgery after patient left OR.</p> <p><b>Treatment Fidelity:</b> All participants followed the same protocol. Anesthesia providers were all blinded to observational end points.</p>	
<b>Primary Outcome and Measures</b>	<p><b>Dependent Variable:</b> Bacterial contamination of frequently touched objects within the AWE.</p> <p><b>DV Measure:</b> Twenty sites of potential contamination were cultured. Each culture was quantified in colony forming units (CFU) per surface area sampled. Average CFU were measured <math>\pm</math> standard error of the mean for CFU present throughout Phase 2.</p>	
<b>Results/Conclusions</b>	<p><b>Statistical Results:</b> The mean number of CFU increased drastically in object contamination during anesthesia induction (mean colony forming units increased from <math>4.0 \pm 1.8</math> CFU at baseline to <math>103 \pm 48</math> CFU at 30 minutes) and at the end of the case during anesthesia emergence (<math>147 \pm 101</math> CFU).</p> <p><b>Conclusion:</b> Critical period of AWE contamination arise from anesthesia induction and emergence, leading to high-risk stopcock transmission events in the operating room. Further work should address improvement of environmental contamination during induction and emergence.</p>	

**Appendix E**

*University of Maryland School of Nursing; Evidence Synthesis*

Project Title: Use of Double-Gloving Technique to Reduce Cross-Contamination on Anesthetic Induction			
JHNEBP Model Level	Total Number of Sources	Author and Quality Rating of each study	Synthesis of Findings
<p><b>Level 1</b> Experimental study · Randomized Controlled Trial (RCT) · Systematic review of RCTs with or without meta-analysis</p>	<p>2 double blind RCT's (Birnbach et al., 2015a; Birnbach et al., 2015b)</p>	<p>Birnbach et al., 2015a; B  Birnbach et al., 2015b; A</p>	<p>Both studies found that double gloving dramatically reduces intraoperative contamination. Birnbach et al. (2015b) concluded that removing the outer double glove during induction and using it to sheath the laryngoscope blade and handle will significantly reduce contamination of the IV hub, patient, and anesthesia work area. Double gloves with no sheathing of laryngoscope blade and handle had significantly more contaminated patient and anesthesia work area sites than double gloves with sheathing in those respective areas (P=0.002; P&lt;0.001).</p>
<p><b>Level II</b> Quasi-experimental studies · Systematic review of a combination of RCTs and quasi-experimental studies, or quasi-experimental studies only, with or without meta-analysis</p>	<p>2 quasi-experimental study  Ed  1 quantitative observational study (Biddle et al)</p>	<p>Porteous et al A  Plemmons et al B  Biddle et al B</p>	<p>Porteous et al (2018) and Biddle et al (2016) found that infection prevention and reduction of AWE contamination can be achieved through double gloving compared to single gloving during induction. Biddle et al (2016) found a 50% reduction of contamination in comparison to single gloving during routine anesthetic induction. Porteous et al (2018) and Plemmons et al (2019) identified not only double gloving as important to decrease cross contamination but implemented it as part of an infection prevention bundle with guideline implementation, education, and visual reminders</p>
<p><b>Level III</b> Non-experimental study · Systematic review of a combination of RCTs, quasi-experimental, and non-experimental studies, or non-experimental studies only, with or without meta-analysis · Qualitative study or systematic review of qualitative studies with or without meta-synthesis</p>	<p>1 quantitative quasi-experimental study (Jaffe &amp; Moriber)  1 non-experimental study (Rowlands et al)</p>	<p>Jaffe &amp; Moriber A  Rowlands et al B</p>	<p>Jaffe &amp; Moriber (2019) and Rowlands et al (2014) found that careful attention to hand hygiene and the use of clean gloves (exposed when removing the contaminated outer glove), can reduce the risk of cross-contamination in the operating room during induction. Induction is identified as a critical point for cross contamination in the operating room.</p>

*Appendix E continued*

**Appendix E**

*University of Maryland School of Nursing; Evidence Synthesis (continued)*

<p><b>Level IV</b> Opinion of respected authorities and/or reports of nationally recognized expert committees/consensus panels based on scientific evidence</p>			
<p><b>Level V</b> Evidence obtained from literature reviews, quality improvement, program evaluation, financial evaluation, or case reports · Opinion of nationally recognized expert(s) based on experiential evidence</p>			
<p>Overall Quality Rating w/rational and Recommendation: B; Good and consistent evidence to support practice change</p>			
<p>Recommendations Based on Evidence Synthesis</p> <ul style="list-style-type: none"> <li>• Strong, compelling evidence, consistent results: solid indication for a practice change.</li> <li>• Good and consistent evidence – practice change</li> <li>• Good but conflicting evidence: questionable indication for practice change; consider risk/benefit analysis</li> <li>• Little or no evidence: no indication for practice change</li> </ul>			